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80810-10 CARTRIDGE TAPE STREAMER SUBSYSTEM

REFERENCE MANUAL

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FCC WARNING

This equipment generates and uses radio frequency energy, and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient the receiving antenna
- Relocate the computer with respect to the receiver
- Move the computer away from the receiver
- Plug the computer into a different outlet so that computer and receiver are on different branch circuits

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful:

How To Identify and Resolve Radio-TV Interference Problems

This booklet is available from the U.S. Government Printing Office; Washington, DC 20402; Stock No. 004-000-00345-4.

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LIST OF EFFECTIVE PAGES

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PREFACE

This manual provides operation and reference information for the CDC® 80810-10 Cartridge Tape Streamer Subsystem, hereafter referred to as the tape storage subsystem. The tape storage subsystem consists of at least one tape cartridge drive, a tape drive formatter circuit card assembly, an enclosure for the cartridge tape drive/formatter (this enclosure also houses a dedicated power supply and fan assembly), tape storage subsystem attachment feature, and interface cable assemblies. The tape storage subsystem is designed and engineered to allow the tape cartridge drive to be attached to IBM Series/1 computing systems.

The tape storage subsystem supports IBM Series/1 mainframes models 4952, 4953, 4954, 4955, and 4956. The tape storage subsystem is not compatible with other Series/1 mainframes or other equivalent computing systems.

This manual is intended for operators, system analysts, programmers, system maintenance personnel, and other personnel who are responsible for operating, programming, or maintaining a Series/1 computing system that is configured using the tape storage subsystem for data storage and retrieval purposes.

Proper use of this manual assumes a familiarity with IBM Series/1 mainframes and associated architectures. In the case of programmers, the manual assumes the user has a working knowledge of Series/1 supervisor and data-management software.

The following IBM manuals contain information complementary to the information presented in this manual:

Title	Publication Number
IBM Series/1 Physical Planning Manual	GA34-0029
IBM Series/1 User's Attachment Manual	GA34-0033

For ordering information on any of the referenced IBM Series/1 publications, contact your IBM representative or the IBM branch office in your area.

The following Control Data manuals provide additional reference and maintenance information related to the tape storage subsystem:

Title	Publication Number
CDC® Standalone Utilities User's Guide, Version 4.0	60466020
CDC® Model 80810-10 Cartridge Tape Streamer Subsystem Hardware Maintenance Manual	60467480

These CDC publications may be ordered from:

Control Data Corporation
Literature and Distribution Services
304 North Dale Street
St. Paul, Minnesota 55103

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GENERAL DESCRIPTION 1

Section 1 describes the general characteristics and functions of and equipment specifications for the 80810-10 Cartridge Tape Streamer Subsystem. The section concludes with a description of 80810-10 Cartridge Tape Streamer Subsystem physical interfaces and power requirements.

GENERAL CHARACTERISTICS

The 80810-10 Cartridge Tape Streamer Subsystem, which is referred to as the tape storage subsystem, provides up to 60 megabytes (MB) of on-line tape storage for IBM Series/1 host computing systems. The tape storage subsystem, which is typically mounted in the Series/1 enclosure, provides a real-time tape storage and retrieval capability for user applications. The tape storage subsystem (figure 1-1) supports the QIC-02/QIC-24 intelligent interface.

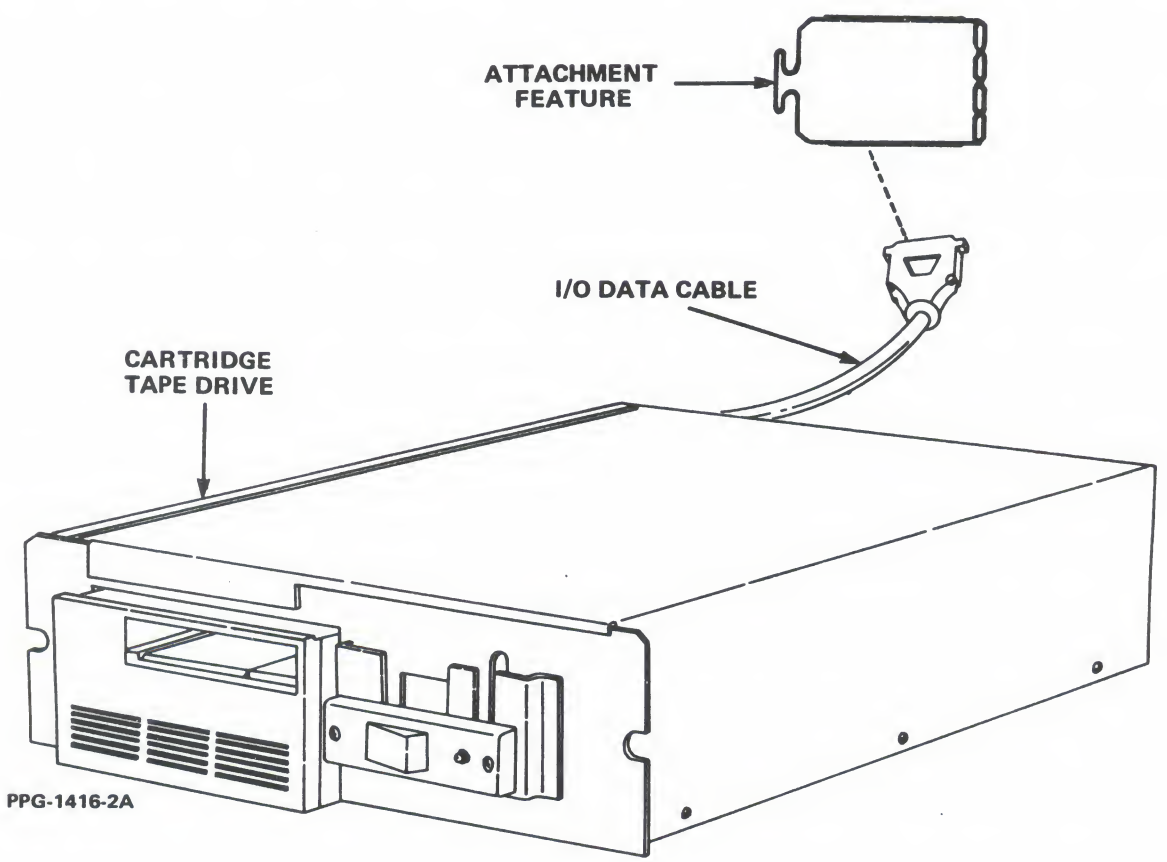


Figure 1-1. 80810-10 Cartridge Tape Streamer Subsystem

The tape storage subsystem consists of a 1/4-inch wide tape cartridge drive and an attachment feature (an interface circuit card assembly) with interconnecting input/output (I/O) cables. A self-contained enclosure that mounts in the Series/1 cabinet, as shown in figure 1-2, houses the tape cartridge drive, along with a dedicated subsystem power supply and fan assembly. The tape cartridge drive may also be table-top mounted (figure 1-3). The tape storage subsystem attachment feature mounts in either the Series/1 processor logic chassis or in the Series/1 I/O expansion chassis.

The storage media for the subsystem consists of a standard ANSI X3.55-type, 600-foot long tape cartridge (3M-type DC600A or equivalent). The drive can record 60 MB of data, using a nine-track format.

The tape storage subsystem may be used in a Series/1 mainframe with other peripheral devices such as the 80220-10 WREN Disk Storage Subsystem and/or compatible 5-1/4-inch flexible disk drives (FDDs). If this is the case, note that each peripheral device attached to the subsystem must have a separate dedicated attachment feature.

For tape storage subsystem initialization, you must configure the Series/1 mainframe with a flexible disk drive. Note that tape storage subsystem initialization may also require the use of a programmer's panel.

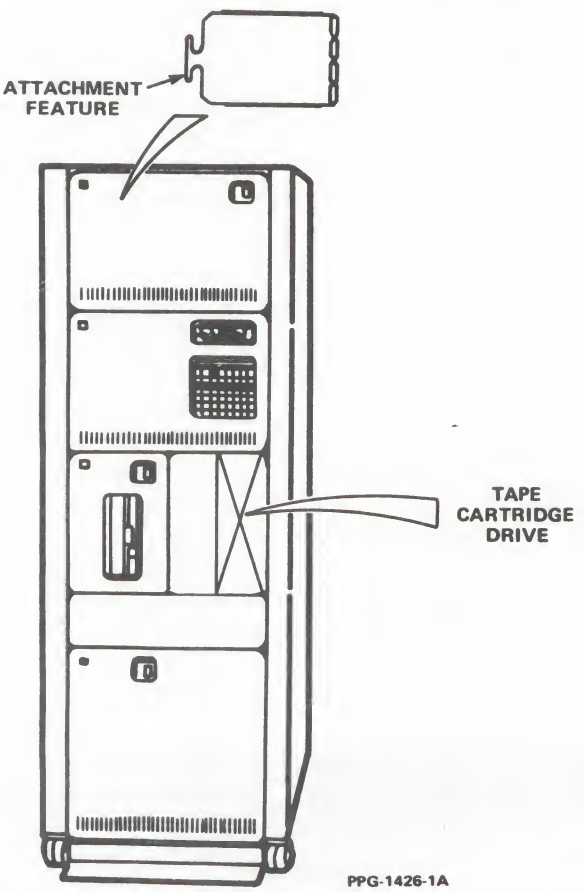


Figure 1-2. Tape Storage Subsystem Installed in IBM Series/1 Processor I/O Chassis

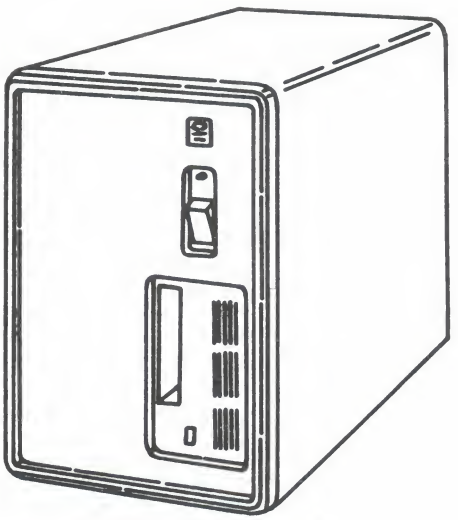


Figure 1-3. Table-Top Version of Cartridge Tape Streamer Subsystem

FUNCTIONS

The following paragraphs provide a brief overview of the functions that the major elements of the tape storage subsystem perform. Figure 1-4 illustrates the general physical relationship between the subsystem elements.

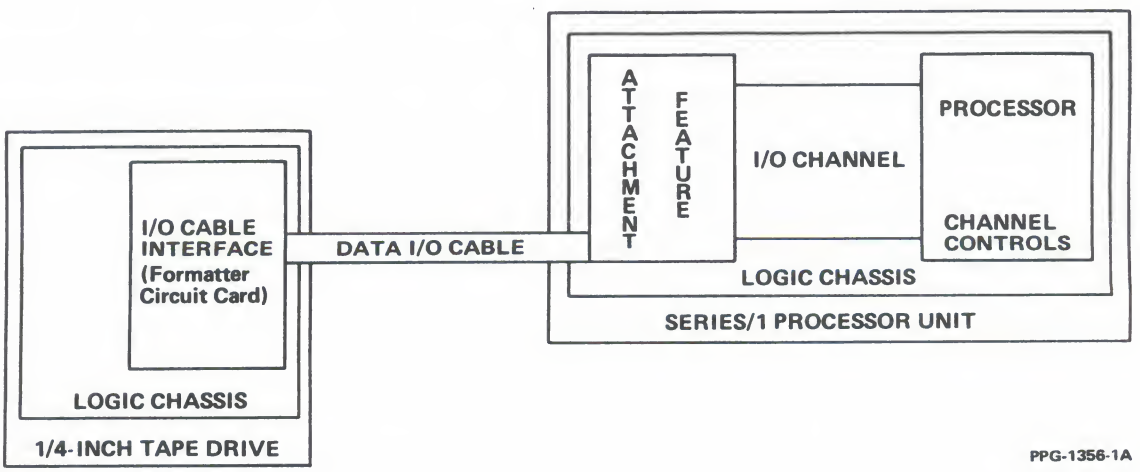


Figure 1-4. General Physical Relationship of the Elements That Make Up the Tape Storage Subsystem

TAPE CARTRIDGE DRIVE

The tape cartridge drive (see figure 1-5) interfaces with and provides peripheral storage capabilities for data processing systems configured with the Series/1 mainframe. The tape cartridge drive is a rack- or table-mounted, tape storage and retrieval device that has an unformatted storage capacity of 60 MB. The maximum data transfer rate for the tape cartridge drive is 90 KBytes per second.

The tape cartridge drive consists of the following major elements:

- Formatter circuit card assembly that enables the QIC-02/QIC-24 intelligent interface
- Microprocessor
- Head carriage and stepper motor assembly
- Read/write head assembly with tape cleaners
- Capstan motor
- Tapehole sensor block assembly

All elements and control electronics for the tape cartridge drive are conveniently mounted on the drive's die cast aluminum deck. The deck is, in turn, enclosed in a 5.75-inch wide, 3.25-inch high, and 8.0-inch deep envelope.

The tape cartridge drive can be configured for constant selection or selection by any one of four discrete drive select lines. The drive sends the select signal to the drive CPU and to an activity LED.

The following paragraphs provide brief descriptions of each of the major elements of the tape cartridge drive. The 80810-10 Cartridge Tape Streamer Subsystem Hardware Maintenance Manual, publication 60467480, provides detailed descriptions of these elements.

Formatter Circuit Card Assembly

The formatter circuit card assembly enables the tape storage subsystem's QIC-02/QIC-24 interface. This intelligent interface provides a convenient byte parallel data bus architecture with asynchronous handshaking to eliminate timing constraints. The formatter circuit card assembly enables the recording of data using the standard QIC-24 data format. Basic resources of the formatter include a Z80A microprocessor, 2Kbytes of random-access memory (RAM), and 8K of read-only memory (ROM).

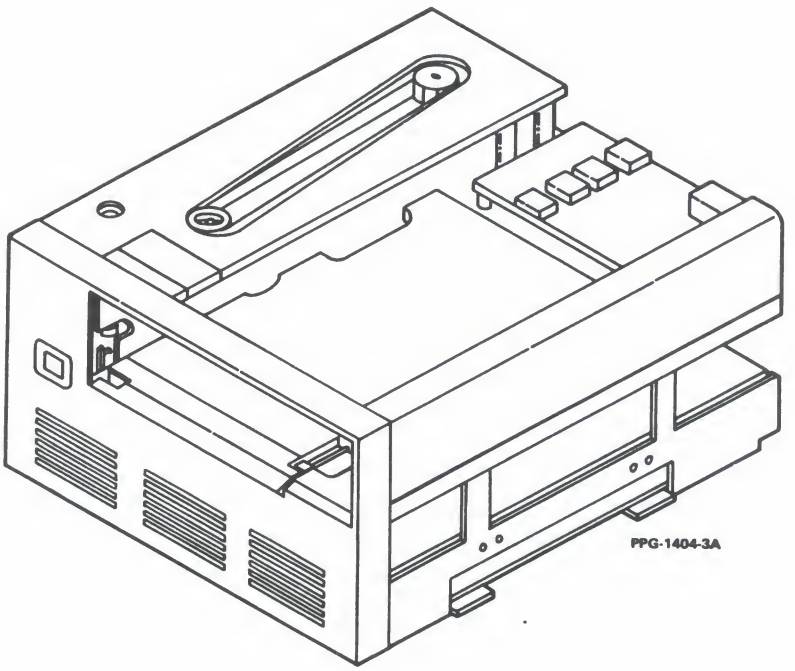


Figure 1-5. Tape Cartridge Drive

Drive Microprocessor

The drive microprocessor is the heart of the tape cartridge drive. The microprocessor maintains control of the drive stepping mechanism and drive motor. The drive microprocessor also decodes commands sent by the tape storage subsystem attachment feature.

Capstan Motor

The drive microprocessor controls the capstan motor. A signal, which the tachometer sends to the capstan motor, controls tape cartridge speed. With such control, the capstan motor holds instantaneous speed variation within $\pm$7 percent and limits long-term speed variation to $\pm$3 percent.

Head Carriage and Stepper Motor Assembly

The stepper motor lead screw-positioning mechanism controls positioning of the head to the desired track. The drive microprocessor generates the drive signal to the stepper motor.

Read/Write Head

A two-channel serpentine recording head, which is arranged with read-after-write poles and a full-track erase bar, performs reading and writing on the tape in the nine-track format.

Tapehole Sensors

The detection system for end-of-tape (EOT), beginning-of-tape (BOT), load point (LP), and early warning (EW) holes uses optical sensor assemblies. The outputs from these assemblies are synchronously clocked into the tape cartridge drive microprocessor.

TAPE STORAGE SUBSYSTEM ATTACHMENT FEATURE

The tape storage subsystem attachment feature is a 10.75-inch by 7.21-inch circuit card assembly that incorporates microprocessor and LSI channel logic. The attachment feature provides the interface between the tape cartridge drive/formatter and the Series/1 I/O channel by servicing commands received from the Series/1 processor. The attachment feature initiates the transfer of appropriate signals, data, and status information to and from the tape cartridge drive. The attachment feature handles data transfers from the Series/1 I/O channel in the cycle-steal mode.

The attachment feature executes commands from the Series/1 processor either under direct program control (DPC) by the processor, or under DPC and in cycle-steal mode. When operating under DPC, the attachment feature receives the commands and executes the commands as processor instructions. The processor does not require the attachment feature executing under DPC to send an interrupt request to the processor upon completion of the command operation. Commands performed under DPC are Prepare, Device Reset, and Read Device ID.

When operating in the cycle-steal (CS) mode, the attachment feature receives the commands under DPC, but executes the commands in the CS mode. In the CS mode, the attachment feature executes the data transfer requested by a command by stealing cycles from the processor while the processor is executing other instructions. In effect, this results in an overlapping of processing and I/O operations. During command execution in CS mode, the attachment feature issues a busy signal to inform the Series/1 processor that the tape cartridge drive is active. After executing the command and completing the data transfer operation, the attachment feature presents an interrupt request to the Series/1 processor. Commands that use the CS mode are Start, Start Cycle-Steal Status, Start Diagnostic 1, Start Diagnostic 2, and Start Diagnostic 3.

The tape storage subsystem attachment feature supports IBM processor models 4952, 4953, 4954, 4955, and 4956. The attachment feature is not compatible for use with other types of mainframes. Figures 1-6 and 1-7 provide functional block diagrams of the LSI channel logic and microprocessor logic, respectively, of the attachment feature.

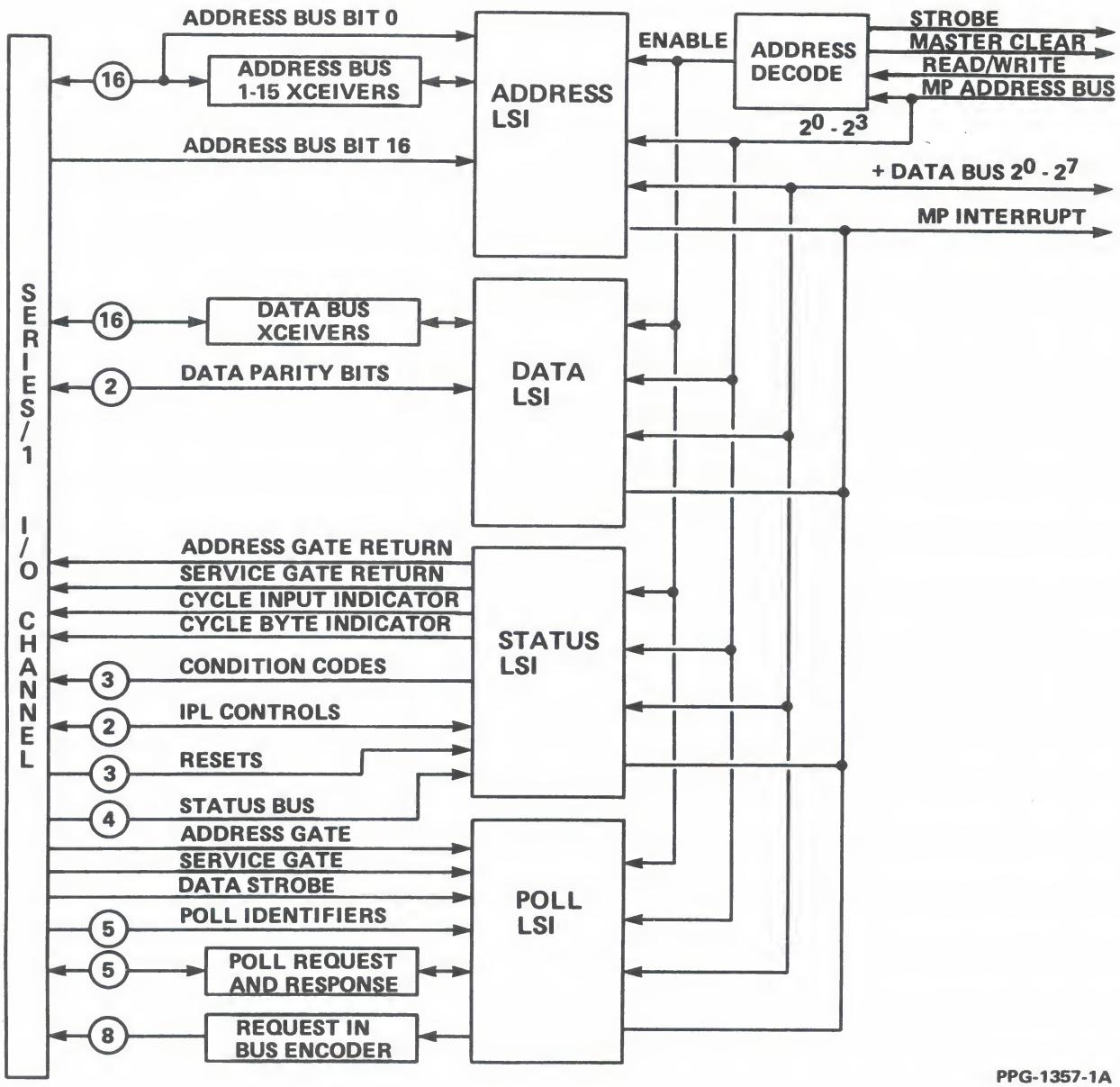


Figure 1-6. Tape Storage Subsystem Attachment Feature
LSI Channel Logic Block Diagram

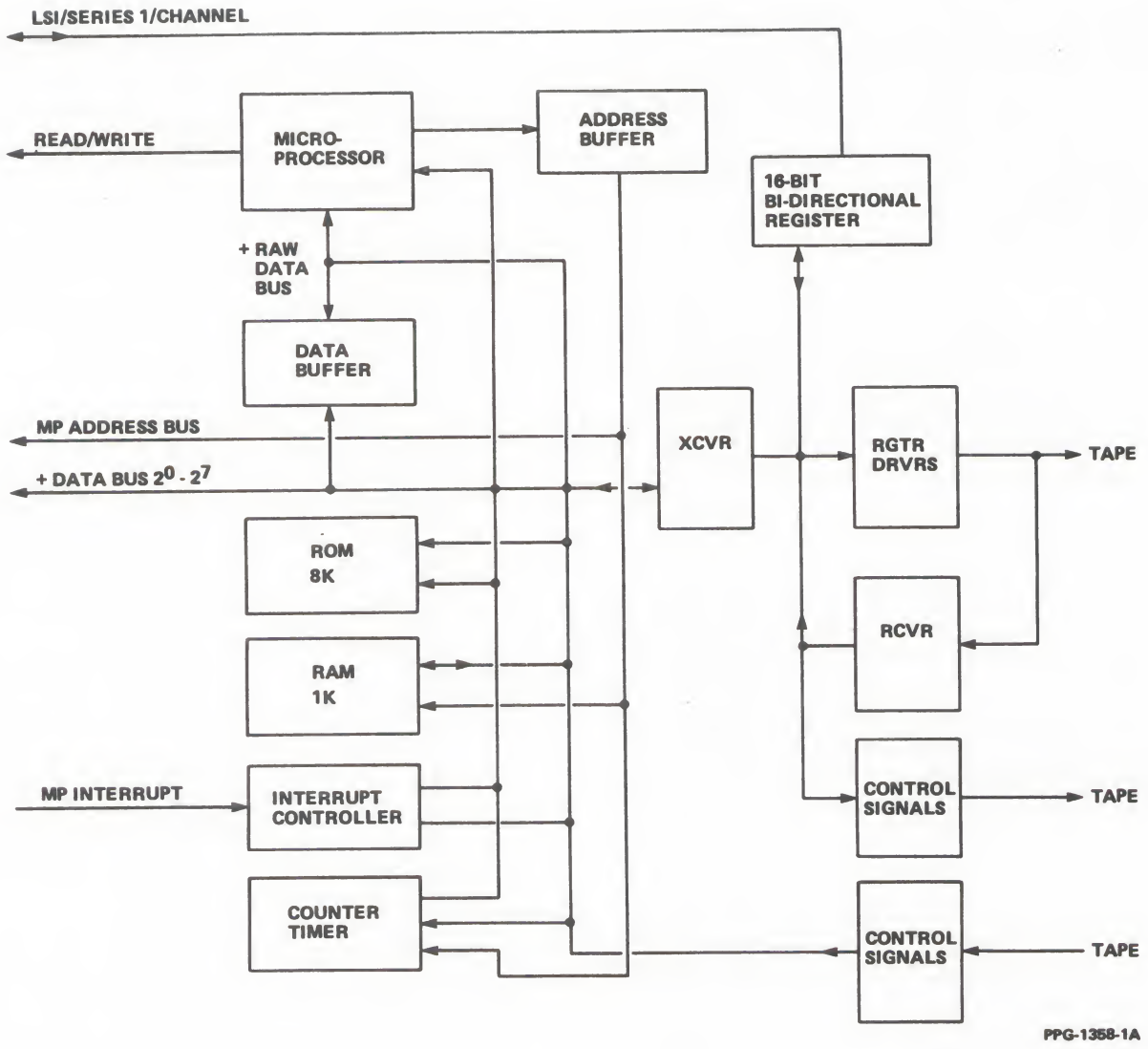


Figure 1-7. Tape Storage Subsystem Attachment Feature
Microprocessor Logic Block Diagram

POWER REQUIREMENTS

Table 1-1 provides power requirements for the tape storage subsystem.

TABLE 1-1. TAPE STORAGE SUBSYSTEM POWER REQUIREMENTS

Specification	Requirements	
	Attachment Feature	Tape Drive
Voltage	+5 Vdc	+5 Vdc and +12 Vdc
Regulation	±10 percent	±5 percent
Current (maximum)	4.2 Amperes	3.2 Amperes
Power dissipation	20 Watts	33 Watts

SPECIFICATIONS

Tables 1-2 and 1-3 list equipment specifications for each part of the tape storage subsystem. Table 1-2 summarizes equipment specifications for the attachment feature. Table 1-3 summarizes equipment specifications for the tape cartridge drive.

TABLE 1-2. ATTACHMENT FEATURE SPECIFICATIONS

Specification	Requirement
Physical	
Length	273.05 mm (10.75 in)
Width	183.13 mm (7.21 in)
Height	8.9 mm (0.350 in)
Weight	14 ounces
Environment	
Operating:	
Temperature	10°C to 40.5°C (50°F to 105°F)
Humidity	8% to 80% (no condensation)
Maximum temperature (gradient)	10°C (18°F) per hour
Nonoperating:	
Temperature	10°C to 51.7°C (50°F to 125°F)
Humidity	8% to 80% (no condensation)
Maximum temperature (gradient)	15°C (27°F) per hour
Shipping:	
Temperature	-40°C to 60°C (-40°F to 140°F)
Humidity	5% to 100% (no condensation)
Maximum temperature (gradient)	20°C (36°F) per hour

TABLE 1-3. TAPE CARTRIDGE DRIVE SPECIFICATIONS

Specification	Requirement
Physical	
Depth (drive only)	215.9 mm (8.50 in)
Depth (enclosure chassis)	457.20 mm (18.0 in)
Width (drive only)	146.1 mm (5.75 in)
Width (enclosure chassis)	323.85 mm (12.75 in)
Height (drive only)	82.6 mm (3.25 in)
Height (enclosure chassis)	107.95 mm (4.25 in)
Weight (drive only)	1.9 kg (4.25 lb)
Weight (enclosure chassis)	9.1 kg (20 lb)
Environment	
Operating:	
Temperature	5°C to 35°C (41°F to 95°F)
Humidity	20% to 80% (no condensation)
Maximum temperature (gradient)	1°C (34°F) per minute
Shock	2.5g max, 1/2 sine wave, 11-ms duration on any axis
Vibration	0.005-in max, peak-to-peak displacement 0 to 63 Hz; 1g max acceleration 63 to 500 Hz
Nonoperating:	
Temperature	-30°C to 60°C (-22°F to 140°F)
Humidity	0% to 99% (no condensation)
Maximum temperature (gradient)	1°C (34°F) per minute
Shock	2.5g max, 1/2 sine wave, 11-ms duration on any axis (with front panel)
Shock	50g max, 1/2 sine wave, 11-ms duration on any axis (without front panel)
Vibration	0.1-in max, peak-to-peak displacement 0 to 17 Hz; 1.5g max acceleration 17 to 500 Hz
Reliability	
Error rates (soft read errors - recoverable)	Less than 1 in 10^8 bits transferred
Error rates (hard read errors - nonrecoverable)	Less than 1 in 10^{10} bits transferred
Seek errors	Less than 1 in 10^6 seeks
Service life	5 years or 30,000 hours

TABLE 1-3. TAPE CARTRIDGE DRIVE SPECIFICATIONS (Contd)

Specification	Requirement
Compliance	
UL478	Yes
CSA C22.2 No. 154	Yes
FCC	Yes
Functional	
Storage capacity	60 MB (unformatted)
Tracks	9
Data transfer rate	90 KBytes/sec at 90 in per second (IPS)
Head type	Read after write with separate erase bar
Recording format	QIC-24
Interface type	QIC-02/QIC-24
Tape speed	90 IPS (during read/write operations)
Tape speed variation	Short term ± 7%, long term ±3%
Start/stop time	300 ms (max)

PHYSICAL INTERFACES

The following paragraphs provide information related to the two physical interfaces used by the tape storage subsystem. The first interface is between the tape storage subsystem attachment feature and the subsystem's formatter/tape cartridge drive. The second interface is between the Series/1 I/O channel and the tape storage subsystem attachment feature.

TAPE STORAGE SUBSYSTEM ATTACHMENT FEATURE/FORMATTER QIC-02/QIC-24 INTERFACE

The following information describes the signal levels, signal termination, signal loading, interface connectors, and I/O pin assignments related to the QIC-02/QIC-24 intelligent interface. The interface provides a convenient, byte-parallel data bus architecture with asynchronous handshaking.

Signal Levels

Tape storage subsystem signal levels are established as follows:

- False, logic 0 (low)
- True, logic 1 (high)

Signals to the tape storage subsystem attachment feature from the tape cartridge drive/formatter have the following TTL levels:

- High = 2.4 to 5.25 Vdc
- Low = 0 to 0.55 Vdc

Signals to the tape cartridge drive/formatter from the tape storage subsystem attachment feature have the following TTL levels:

- High = 2.0 to 5.25 Vdc
- Low = 0 to 0.8 Vdc

Signal Termination

The recommended signal termination is 220 ohms to +5 Vdc and 330 ohms to logic ground with resistance tolerance of $\pm$5 percent maximum.

Signal Loading

Maximum device loading on any signal in the interface is 2.0 mA plus required terminations.

Interface Signal Connector

The interface connector at the formatter is a 50-conductor edge connector; the mating connector is a 3M-type 3415-001 or equivalent.

Attachment Feature/Formatter Interface I/O Signal Pin Assignments

Table 1-4 shows pin assignments between the tape storage subsystem attachment feature and tape cartridge drive/formatter. Figure 1-8 illustrates the interface.

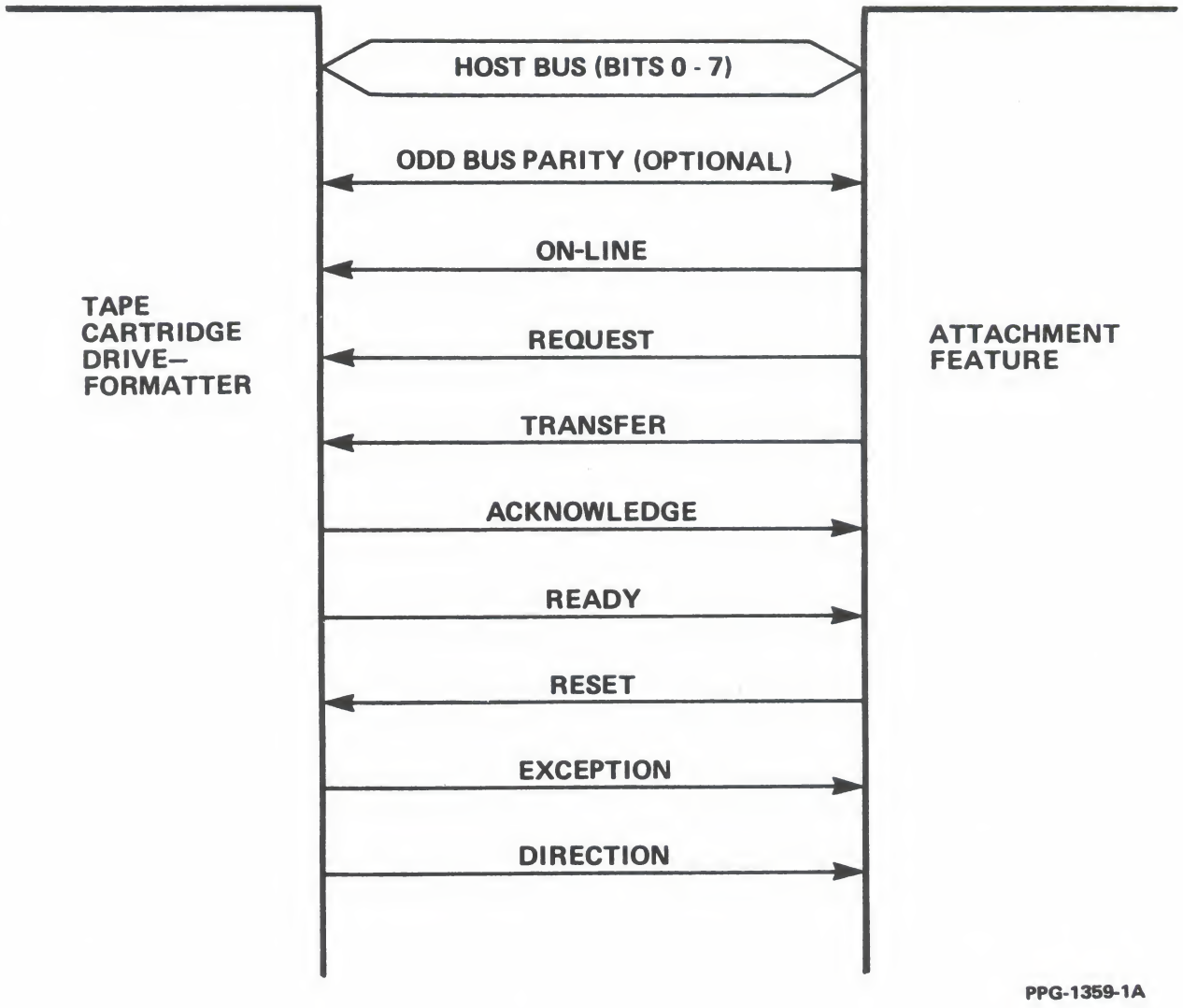


Figure 1-8. Attachment-Feature-to-Tape-Cartridge-Drive Interface

TABLE 1-4. ATTACHMENT FEATURE/FORMATTER I/O PIN ASSIGNMENTS

Pin No.†	Mnemonic††	To	Description
02,04, 06,08	NUS-	X	Not used - unconnected signal lines.
10	HBP-	B	Host bus odd parity - reserved for optional odd bus parity.
12	HB7-	B	Host bus bit 7 - most-significant bit of 8-bit bidirectional data bus.
14	HB6-	B	Host bus bit 6
16	HB5-	B	Host bus bit 5
18	HB4-	B	Host bus bit 4
20	HB3-	B	Host bus bit 3
22	HB2-	B	Host bus bit 2
24	HB1-	B	Host bus bit 1
26	HB0-	B	Host bus bit 0 - least-significant bit of 8-bit bidirectional data bus.
28	ONL-	D	On-line - The attachment feature generates this control signal, activating the signal prior to transferring a Read or Write command and deactivating the signal to terminate the Read or Write command.
30	REQ-	D	Request - The attachment feature generates this control signal when command data has been placed on the data bus in command mode or when status has been taken from the data bus in status input mode. The attachment feature can only assert the Request signal when the drive/ formatter asserts the RDY- or EXC- signals.

†All odd pins must be connected to logic ground at the attachment feature.
††The To nomenclature is as follows:

X = undefined
B = bidirectional
D = drive/formatter
H = attachment feature (host)

TABLE 1-4. ATTACHMENT FEATURE/FORMATTER I/O PIN ASSIGNMENTS (Contd)

Pin No.†	Mnemonic††	To	Description
32	RST-	D	Reset - This signal causes tape drive initialization, default selection to device 0, and assertion of the Exception signal.
34	XFR-	D	Transfer - The attachment feature generates this control signal to indicate that data has been placed on the data bus in write mode or that data has been taken from the data bus in read mode.
36	ACK-	H	Acknowledge - The drive/formatter generates this signal to indicate that data has been taken from the data bus in write mode or that data has been placed on the data bus in read mode.
38	RDY-	H	Ready - The drive/formatter generates this signal to indicate one of the following:
		1	Data has been taken from the data bus in command transfer mode.
		2	Data has been placed on the data bus in status input mode.
		3	A BOT, Re-tension, or Erase command has been completed (following issuance).
		4	The drive/formatter is ready to receive the next block or ready to receive a write or write file mark (WFM) command from the attachment feature in the write mode.
		5	The drive/formatter completed a WFM command in the write file mark mode.

†All odd pins must be connected to logic ground at the attachment feature.
††The To nomenclature is as follows:

X = undefined
B = bidirectional
D = drive/formatter
H = attachment feature (host)

TABLE 1-4. ATTACHMENT FEATURE/FORMATTER I/O PIN ASSIGNMENTS (Contd)

Pin No.†	Mnemonic††	To	Description
		6	The drive/formatter is ready to transmit the next block to the attachment feature or ready to receive a read or read file mark (RFM) command from the attachment feature in the read mode.
		7	The drive/formatter is ready to receive a new command.
40	EXC-	H	Exception - The drive/formatter generates this signal to indicate that an exception condition exists in the drive and that the attachment feature must issue a Status command and perform a status input to determine the cause of the exception condition.
42	DIR-	H	Direction - The drive/formatter generates this signal. When the signal is false, the signal causes attachment feature data bus drivers to assert their data bus levels and drive/formatter data bus drivers to assume high-impedance status. When the signal is true, the signal causes attachment feature data bus drivers to assume high-impedance status and drive/formatter data bus drivers to assert their data bus levels.
44,46, 48,50	NUS-	X	Not used - unconnected signal lines.

†All odd pins must be connected to logic ground at the attachment feature.
††The To nomenclature is as follows:

X = undefined
B = bidirectional
D = drive/formatter
H = attachment feature (host)

ATTACHMENT-FEATURE-TO-SERIES/1 I/O CHANNEL INTERFACE

A set of four 24-pin connectors that are mounted on the back edge of the attachment feature (see figure 1-9 for locations) provide the physical interface between the attachment feature and the Series/1 I/O channel (see figure 1-10). These connectors are compatible with the processor's backpanel connectors in the Series/1 processor unit. All signals are TTL compatible.

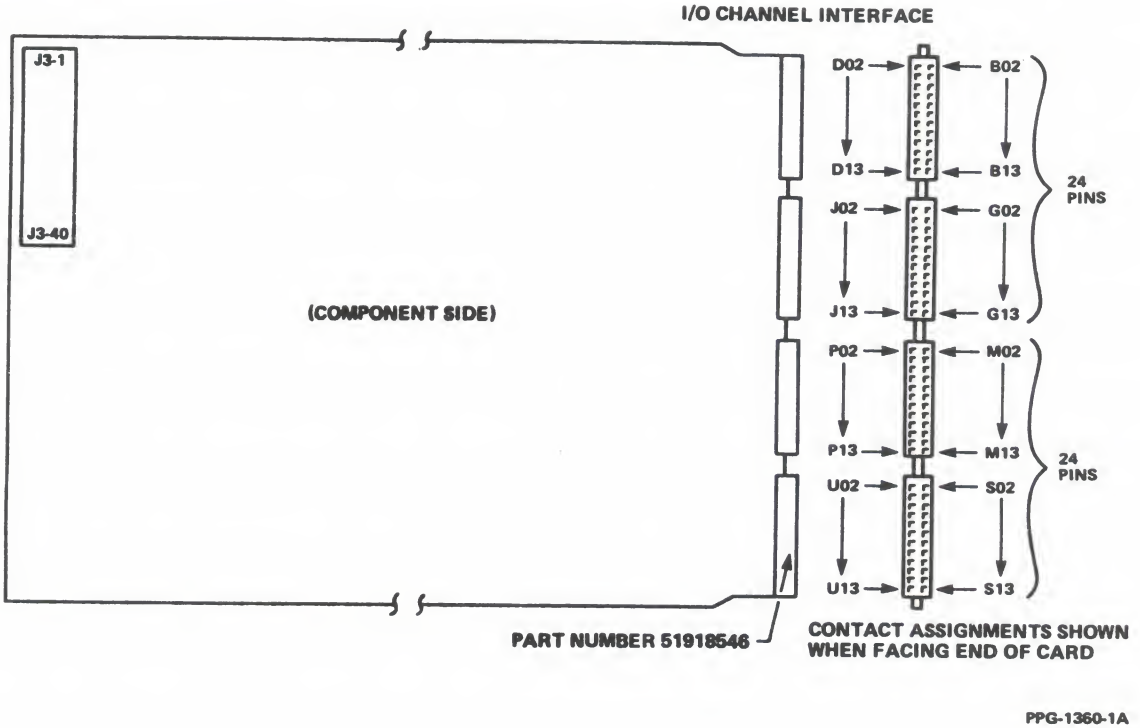


Figure 1-9. Attachment Feature Physical Interface Arrangement

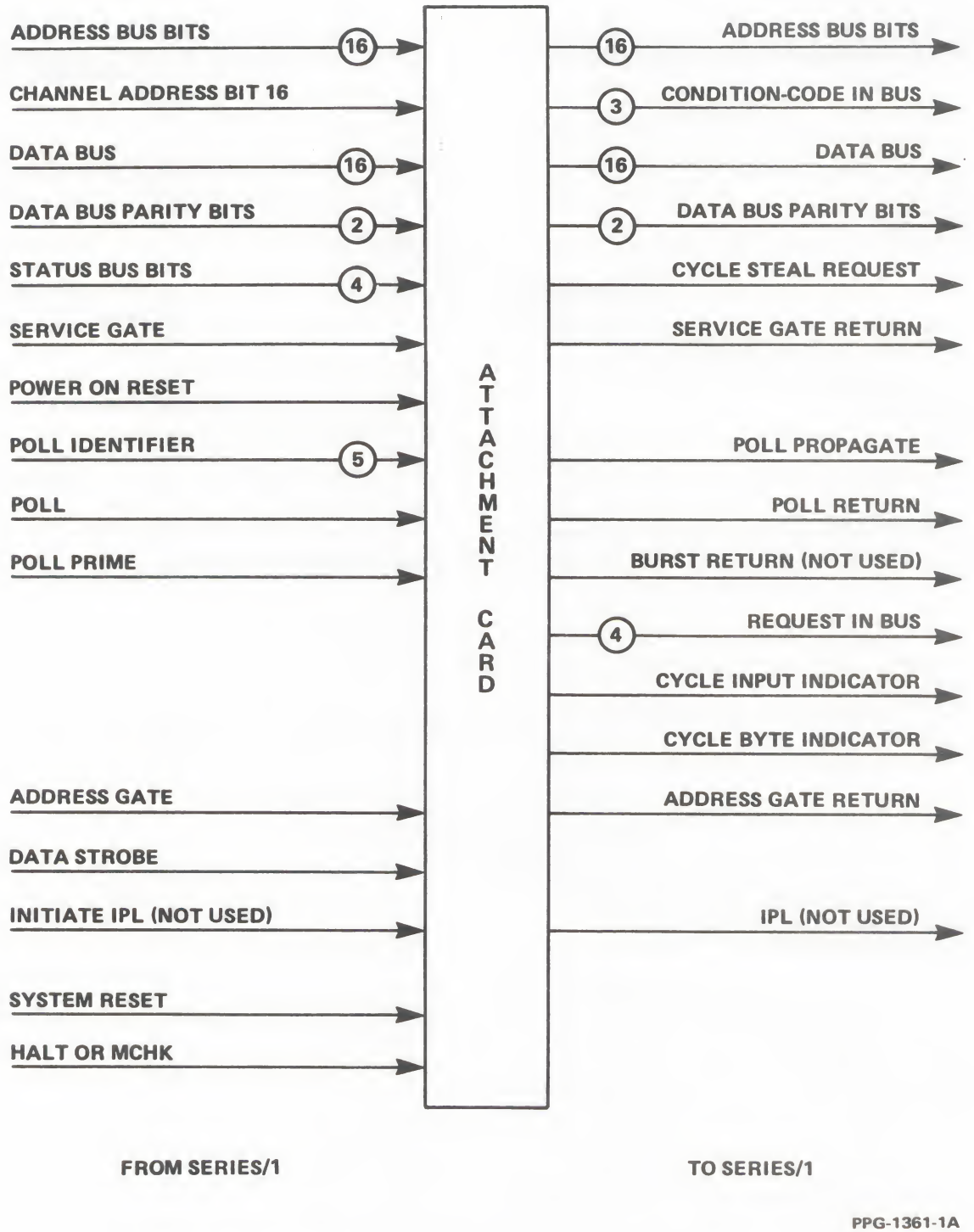


Figure 1-10. Attachment-Feature-to-Series/1 I/O Channel Interface

DC POWER CONNECTOR

An AMP 1-480426-0 connector provides power to the tape cartridge drive. The mating connector is an AMP 1-480424-0 using AMP 60619-1 female contacts. Configuration of the dc power connector is as follows:

Pin	Values
1	+12 Vdc
2	+12 V return
3	+5 V return
4	+5 Vdc

OPERATION 2

This section describes the tape storage subsystem operator controls and indicators, power-on and power-off procedures, cartridge loading/unloading procedures, and subsystem initialization procedures. The section also covers operating considerations and precautions. For the procedures required to load and operate the tape storage subsystem utilities, refer to the Standalone Utilities User's Guide, Version 4.0, publication 60466020.

OPERATOR CONTROLS AND INDICATORS

The only operator indicators associated with the tape cartridge drive are an activity LED and a Power On LED. Both indicators are conveniently mounted on the front panel of the tape cartridge drive enclosure. The Power On indicator, which is located on the Power ON/OFF switch assembly, lights whenever power is applied to the tape cartridge drive. The activity indicator (physically located to the left of the Power ON/OFF switch assembly) lights whenever the tape cartridge drive is selected during save/restore operations.

The only operator controls associated with the tape cartridge drive are a two-way voltage select switch, which is located on the outside rear panel of the enclosure, and the Power ON/OFF switch, which is located on the front panel of the enclosure. The two-way voltage select switch enables 115-Vac or 220-Vac operations. Note that the switch displays the selected voltage (115 Vac or 220 Vac).

The tape cartridge used with the tape storage drive has a write protect mechanism (figure 2-1). To protect data on the cartridge from being written over, turn the write protect indicator on the cartridge so the indicator points to the SAFE indicator.

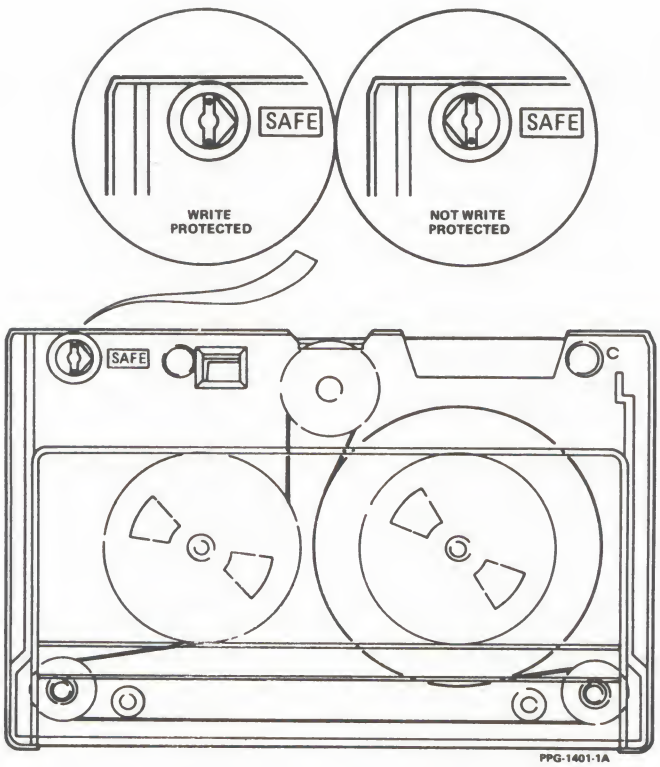


Figure 2-1. Write Protect Feature

POWER ON PROCEDURE

Perform the following steps to power on the tape storage subsystem:

1. Verify the connection of the subsystem power and I/O cables.
2. Place the tape cartridge drive Power ON/OFF rocker switch to the ON (up) position. Locate the switch on the front panel of the tape cartridge drive enclosure.
3. Power up the Series/1 mainframe.

4. Verify that the Power On LED located on the Power ON/OFF switch assembly of the tape cartridge drive enclosure is lit.

5. Install your tape cartridge as described by the Cartridge Loading/Unloading procedures in this section.

NOTE

If the tape storage subsystem does not power up when you do steps 1 through 5, refer to the 80810-10 Cartridge Tape Streamer Subsystem Hardware Maintenance Manual, publication 60467480, for applicable maintenance instructions.

POWER OFF PROCEDURE

Perform the following to power down the tape storage subsystem:

1. Remove your tape cartridge from the tape cartridge drive (if loaded) as described by the Cartridge Loading/Unloading procedures in this section.

2. Place the tape cartridge drive enclosure Power ON/OFF rocker switch to the OFF (down) position. Locate this switch on the front panel of the tape cartridge drive enclosure.

CARTRIDGE LOADING/UNLOADING

The tape cartridge drive allows loading the tape cartridge in only one orientation; that is, with the tape side facing the activity LED indicator side of the drive. When loading a tape cartridge, push the cartridge into the front loading slot until the drive restricts further movement. Figure 2-2 illustrates tape cartridge loading.

You can unload a tape cartridge (even during operation) by simply removing the cartridge from the loaded position. When unloading, push in on the tape cartridge enough to allow the drive to release and eject the cartridge. Figure 2-3 illustrates tape cartridge unloading.

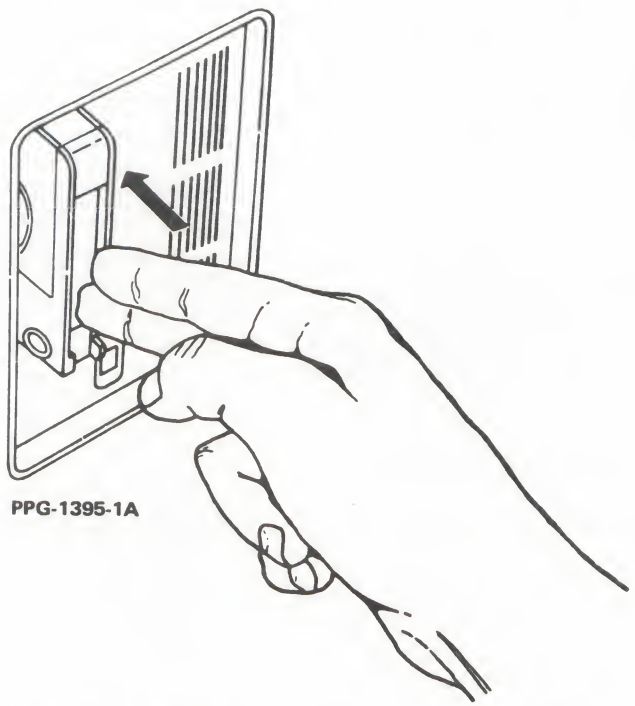


Figure 2-2. Tape Cartridge Loading

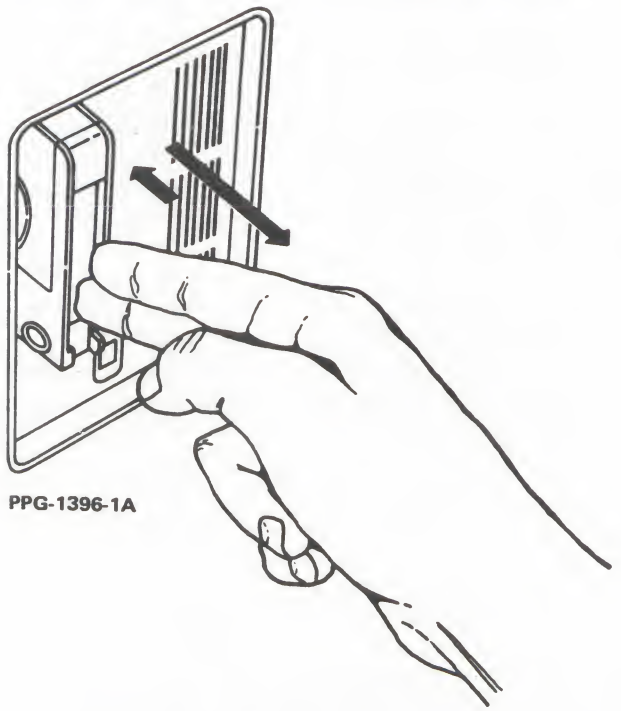


Figure 2-3. Tape Cartridge Unloading

OPERATING CONSIDERATIONS AND PRECAUTIONS

The following information describes various operating considerations and precautions. Failure to follow these precautions may result in equipment problems or damage.

- Never expose tape cartridges to dirt or other contaminates, moisture, or extreme temperatures.
- Never open the tape access cover to expose the tape when the cartridge is not in use.
- Avoid touching the tape. Touching the tape surface can contaminate the magnetic coating.
- Avoid abrupt motions when handling tape cartridges. Abrupt motions can distort tape position.
- Never drop a tape cartridge. Hard impact may damage the plastic cover.
- Never use a tape cartridge that is damaged or is suspected of being faulty. ANY ATTEMPT TO USE A DAMAGED CARTRIDGE MAY DAMAGE THE TAPE CARTRIDGE DRIVE. Discard defective tape cartridges immediately to prevent their inadvertent use.
- Store tape cartridges in an environment that meets the storage criteria prescribed by the tape cartridge manufacturer when the cartridges are not in use. Pay particular attention to the manufacturer guidelines for temperature and humidity.
- Never store or place the tape cartridges in areas close to electric motors, transformers, or other similar devices. The magnetic fields generated by these devices can damage the tape cartridges.
- Clean the drive's recording head and tape cleaners after using a new tape cartridge for 2 hours. A lintless cotton swab with isopropyl alcohol or IBM tape cleaner is recommended for cleaning.

NOTE

The Maintenance section of the 80810-10 Cartridge Tape Streamer Subsystem Hardware Maintenance Manual, publication 60467480, contains the head cleaning procedures.

- Clean the drive's recording head and tape cleaners after every 8 hours of actual use during normal operations.
- Certify all new tape cartridges before use. Use the tape utility program provided with the unit for this certification.

INITIALIZATION

NOTE

Tape storage subsystem initialization requires use of the Series/1 mainframe's flexible disk drive (FDD). Initialization also requires a programmer's panel.

Tape storage subsystem initialization consists of generating a new system configurator table or of adding the subsystem to the existing system configurator table of the CDC BASIC diagnostic diskette.

You must add the tape storage subsystem to the system configurator table on the applicable CDC BASIC diagnostic diskette. The configurator table on each diskette (as a minimum) must contain the configuration information for all devices to be tested by that diskette. The following procedure describes the steps to use for updating the configurator table by either adding the devices individually or by performing the configure system option (0C).

NOTE

The configurators on IBM diskettes do not recognize CDC devices; therefore, do not attempt to use an IBM configurator to construct the configurator table on a CDC BASIC diskette. If you use an IBM diskette, all CDC devices will be configured wrong in the table.

1. Apply power to the Series/1 FDD and install the CDC BASIC diagnostic diskette, part number 22250150.

NOTE

The CDC BASIC diagnostic diskette has a preassigned alternate console selected for either a CDC 80610 Display or an IBM 4979 Display (AATT = 0442).

2. Place the IPL Source switch on the Series/1 operator/programmer panel to the Alternate or the Primary position, as applicable, to enable loading from the diskette.

3. Place the Mode switch on the Series/1 operator/programmer panel to the Diagnostic position.

4. Press the Load switch on the Series/1 operator/programmer panel to execute the IPL diagnostic that resides on the diagnostic diskette (execution time is approximately 10 seconds). Go to step 4a, 4b, 4c, or 4d, as applicable.

   a. If an alternate console is assigned per the preconfigured diskette (see note of step 1), all messages should appear on the assigned alternate console and on the operator/programmer panel, if present.

1) The appearance of a configurator error message on the CRT screen (3822 on the operator/programmer panel) signifies that the configurator table does not match the system configuration. Ignore this error and go to step 6 to update the table.

2) The appearance of a disconnect customer interface message on the CRT screen (382A on the operator/programmer panel) indicates that you should proceed to step 12.

3) The appearance of any other message on the CRT screen (38XX on the operator/programmer panel) requires that you correct this error before continuing. Refer to the Common Halt List discussion for a list of error halt codes.

b. If either a 80610, 4978, 4979, or TTY display device is present but no message appears on the CRT screen, and an operator/programmer panel is not available, complete the following steps to assign an alternate console:

1) Install an existing diskette (IBM or CDC) that has an alternate console assigned correctly.

2) Press the Load switch to IPL the diskette.

3) When the IPL is completed, a message appears on the CRT screen. Remove the diskette and install the new diskette that is to be configured.

4) Enter B38F9 (menu appears on the screen).

5) Enter F02 to select the patch program option.

6) Enter F38F1 (dataset name).

7) Enter F3008 (start address).

8) Enter F0001 (word count).

9) Enter the device address and the device type of the desired alternate console that uses the format of FAATT where:

AA = device address
TT = device type of alternate console as follows:

40 for a TTY device
42 for either a CDC 80610 or an IBM 4979 display
45 for an IBM 4978 display
81 for FPMLC with RPQ 2350*
E6 for Multifunction*
E8 for ACCA single line*
E9 for ACCA multi line*
EA for FPMLC*

If using a 3101 display, use the switch settings in figure 2-4.

THE DIAGNOSTIC TO LOAD AND RUN IS:

A SUPPORTED ALTERNATE CONSOLE IS:			AA** TT**
1310 MULTIFUNCTION	@		AAE6
3101 DISPLAY	@		AA81
3101 DISPLAY ACCA SL	$		AAE8
3101 DISPLAY ACCA ML	$		AAE9
3101 DISPLAY FPMLC	@ &		AAEA
TTY ATTACHMENT	%		AA40
5251 DISPLAY	E400	E400	AAE4 00XY

** AA = CONSOLE DEVICE ADDRESS
** TT = CONSOLE DEVICE TYPE
X = CABLE ADDRESS (0-3) IN REGISTER 1
Y = STATION ADDRESS (0-6) IN REGISTER 1

* @ 3101 SWITCH SETTING CHECKLIST WHEN SUPPORTED BY FPMLC CURRENT INTERFACE, RPQ DQ2350 AND 1310 MULTI FUNCTION.

```
12345678 12345678 12345678 12345678
 X        X        X X      X  X
X X    X   X                 XX
```

*** & 3101 SWITCH SETTING CHECKLIST WHEN SUPPORTED BY FPMLC WITH RS232C.

```
12345678 12345678 12345678 12345678
 XXX      X        X X      X  X
X      X   X                 XX
```

* % 3101 SWITCH SETTING CHECKLIST WHEN SUPPORTED BY TTY WITH EIA INTERFACE.

```
12345678 12345678 12345678 12345678
  X                 XX      X  X
XX     X  X         X        XX
```

% * 3101 SWITCH SETTING CHECKLIST WHEN SUPPORTED BY TTY CURRENT INTERFACE.

```
12345678 12345678 12345678 12345678
   X                 XX      X  X
XXX    X  X        X         XX
```

Figure 2-4. 3101 Display Switch Settings During Initialization (Sheet 1)

```
***          $   3101 SWITCH SETTING CHECKLIST WHEN
                 SUPPORTED BY ACCA SL - ML EIA RS232C
                 12345678 12345678 12345678 12345678
                  XXXX               X X      XXX
                 X      X  XX                 X

                 X = SWITCH POSITION.  DO NOT CHANGE
                      THE POSITIONS THAT ARE BLANK.
                      LEAVE THEM IN THE POSITION
                      FOUND.  WHEN DONE, RETURN MOVED
                      SWITCHES TO ORIGINAL POSITION.
                 3101 BAUD RATE IS 9600 IN THE ABOVE.
               +--------------------------------------+
```

Figure 2-4. 3101 Display Switch Settings During Initialization (Sheet 2)

10) A patch complete message indicates that the new alternate console assignment is written on diskette.

11) Press the Load switch. After the IPL is completed, all messages should now appear on the assigned alternate console. Go to step 6 to update the configurator table.

c. If a display or TTY is present and a 3801 halt code appears in the register indicators of the operator/programmer panel, but no message appears on the CRT screen, do the following steps to assign an alternate console other than the programmer panel:

1) Enter (B),6,(I),(I) to continue.

2) The next halt code is a 382A (secure customer interface), a 3822 (configuration errors on system), or a 382E (option table available for entry).

- If a 382A halt code occurs, secure the customer interface and enter the following:

  (B),6,(I),(I) to advance to 3822 or 382E

- If a 3822 halt code occurs, enter the following to advance to 382E:

  (B),1F,(I),(B),0300,(I),(I)

- If a 382E halt code occurs, enter the following to select alternate console option:

  (B),1F,(I),(B),0400,(I),(I)

3) The next halt code is a 3821 (enter alternate console device address and device type). Enter the following:

(B),1F,(I),(B),AATT,(I),(I)

Where: AA = device address
TT = device type

If a 3829 (no device) halt occurs, an entry error has been made.

Enter the following to continue and reselect the alternate console option:

(B),6,(I),(I)

4) The next halt code is a 382E (the option table is available for entry). Enter the following to write the new alternate console assignment on the diskette:

(B),1F,(I),(B),0D00,(I),(I)

5) The next halt code is a 382C (copy configurator table to another diskette?). Enter the following to terminate:

(B),1F,(I),(B),0500,(I),(I)

6) A 3800 or 3805 halt code indicates completion of program terminate function.

7) Press the Load switch to re-IPL. All messages should now appear on the CRT screen of the assigned alternate console. Go to step 5 to update the configurator table.

d. If no alternate display or TTY console is present and a 3801 halt code appears in indicators of operator/programmer panel, perform the following steps to change the configurator table manually to assign the operator/programmer panel as an alternate console:

1) To continue, enter:

(B),6,(I),(I)

2) The next halt code is a 382A (secure customer interface), a 3822 (configuration errors on system), or a 382E (option table available for entry).

- If a 382A halt code occurs, secure the customer interface and enter the following to advance to 3822 or 382E:

  (B),6,(I),(I)

- If a 3822 halt code occurs, enter the following to advance to 382E:

  (B),1F,(I),(B),0300,(I),(I)

- If a 382E halt code occurs, enter the following to select the assign alternate console option:

  (B),1F,(I),(B),0400,(I),(I)

3) The next halt code is a 3821 (enter the alternate console device address and device type). Enter the following to assign the operator/programmer panel as an alternate console:

   (B),1F,(I),(B),0000,(I),(I)

4) The next halt code is a 3832 (operator/programmer panel is the assigned alternate console). Enter the following to continue:

   (B),6,(I),(I)

5) The next halt code is a 382E (option table is available for entry). Enter the following to write the new alternate console assignment on the diskette:

   (B),1F,(I),(B),0D00,(I),(I)

6) The next halt code is a 382C (copy the configurator table to another diskette?). Enter the following to terminate:

   (B),1F,(I),(B),0500,(I),(I)

7) A 3800 (ready) halt code indicates the system is ready for any valid input. Go to changing the Configurator Table Using the Operator/Programmer Panel discussed later in this section to update the configurator table manually or to Configure System Option (0C) Using Operator/Programmer Panel to perform configure system option (0C).

5. If the diskette has no configuration errors, enter B38F0 to display the option table.

6. Enter F03 and press the ENTER key on the keyboard of the assigned alternate console to display the option table.

7. Enter F0B to bypass the option table display.

8. Skip steps 9 through 16 if the configurator table is to be updated manually and go directly to step 17.

9. Enter F0C to select the configure system option and follow the series of prompts on the alternate console display. The new configurator table is written automatically onto the diskette.

10. An option to write the configurator table on another diskette or to terminate appears on the CRT screen.

    a. Terminate by entering F05. A PT RDY ENTER then displays on the CRT screen.

11. Enter B38F0 to display the option table.

12. Enter F0B to bypass the option table display.

NOTE

Some CDC and IBM devices have the same read device ID codes assigned. The configure system option assigns CDC device types to all IBM devices that have the same read ID code as the CDC devices. You must change these IBM devices in the configurator table manually. To determine which device types in the table require changing, enter F09 (Print System Equipment) to display all system devices contained. Compare this listing with the customer equipment list to determine which device types to change.

13. Enter F01 to display the configurator table.

14. Enter F03 to select the modify option.

15. Enter the correct device type for each table entry to be modified by following the prompts on the alternate console. Refer to table 2-1 for device type assignments.

TABLE 2-1. IBM/CDC DEVICE TYPE ASSIGNMENTS

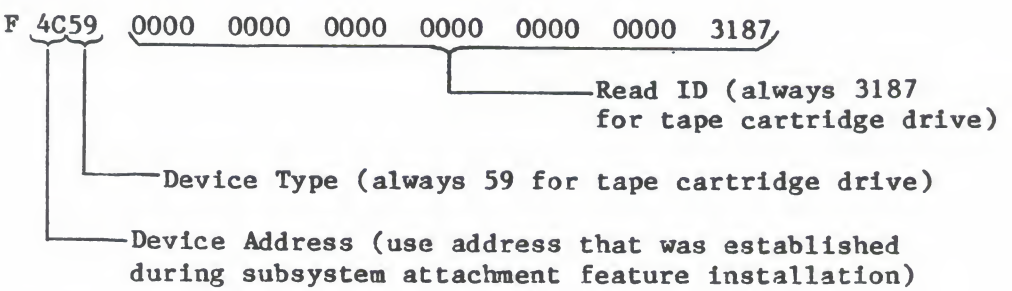
Read ID Code	IBM Product	Device Type	CDC Product	Device Type
0406	4979	44	80610	42
0206	4974	64	80420	62
0106	4964	48	80210	46
00AA	4962	78	80230	72
00CA	4962	78	80230	72
0306	4973	68	80450	66
3187	N/A	N/A	80810	59

16. Go to step 20 to verify the configurator table entries.

17. Enter F01 to display the configurator table.

18. Enter F0A (add option), F02 (delete option), F03 (modify option), or any other desired option from the option table (as applicable) to make changes or additions to configurator table.

19. Enter the tape cartridge drive device parameters per the following format and press the ENTER key:



The response to this input is as follows:

```
FUNCTION
ENTER
```

NOTE

You may enter configuration information for all other CDC devices contained in the system at this time. Refer to the applicable site maintenance information manual for individual device entry parameters.

20. Enter F01 and press the ENTER key to display the configuration table. Verify that these parameters were correctly entered.

21. Enter F0D and press the ENTER key to write the new configuration information on the diskette. If additional diskettes are to be written, install the diskette and repeat this step for each diskette.

22. Enter F05 to terminate the program. A PT ENTER message indicates that the terminate function is completed.

NOTE

This concludes the initialization sequence. If at this time you desire to run the tape storage subsystem diagnostics, refer to the Maintenance section in the CDC® 80810-10 Cartridge Tape Streamer Subsystem Hardware Maintenance Manual, publication 60467480. If you desire to use the tape cartridge drive to save or restore data, refer to the Standalone Utilities User's Guide, Version 4.0, publication 60466020, for applicable instructions. To save/restore data using EDX, refer to appendix C of the Cartridge Tape Streamer Subsystem Hardware Maintenance Manual for applicable instructions.

PROGRAMMING CONSIDERATIONS 3

This section describes the input/output (I/O) communications that occur between the Series/1 processor and the tape storage subsystem. Although the tape storage subsystem has some characteristics that are different from those inherent to IBM Series/1 storage media, the operations described are compatible with Series/1 data storage and retrieval operations. Likewise, Series/1 I/O channel communications with the tape storage subsystem vary slightly, but are compatible with, those used for IBM Series/1 storage devices.

This section also describes:

- Tape storage subsystem interfaces (internal and external)
- Tape storage subsystem responses to Series/1 processor commands
- Resets
- Built-in test features

INTERFACE OVERVIEW

The tape storage subsystem attachment feature provides the interface between the Series/1 I/O channel and the tape cartridge drive. The attachment feature is responsible for servicing commands received from the Series/1 processor, initiating the appropriate read/write (R/W) instructions, and controlling data and status transfers to and from the tape cartridge drive (via the drive's formatter circuit card assembly). The attachment feature handles data transfers to and from the Series/1 I/O channel in the cycle-steal mode.

The attachment feature executes commands from the Series/1 processor either under direct program control (DPC) by the processor or under DPC and in cycle-steal mode. When the attachment feature executes under DPC, the feature receives and executes commands as processor instructions and does not send an interrupt request to the processor upon completion of the command operation. The feature executes the Prepare, Device Reset, and Read Device ID commands under DPC.

When the attachment feature operates in the cycle-steal (CS) mode, the attachment feature receives the commands under DPC, but executes the commands in the CS mode. In the CS mode, the attachment feature executes a command-requested data transfer by stealing cycles from the processor while the processor is executing other instructions. In effect, this results in an overlapping of processing and I/O operations. When executing commands in CS mode, the attachment feature issues a busy signal, which informs the Series/1 processor that the tape cartridge drive is active. After executing the command and completing the data transfer operation, the attachment feature presents an interrupt request to the Series/1 processor. The Start, Start Cycle-Steal Status, Start Diagnostic 1, Start Diagnostic 2, and Start Diagnostic 3 commands use the CS mode.

The attachment feature receives a Series/1 processor command as a pair of 16-bit words. These words are referred to as the immediate device control block (IDCB). The first 16-bit word (figure 3-1) contains command and address information. If the attachment feature is to execute the command under DPC, the second 16-bit word contains an immediate data word (figure 3-1) required for the command operation. If an immediate data word is not required, the attachment feature zero-fills this word. If the attachment feature executes the command in CS mode, the second 16-bit word contains the address of an eight-word data block that provides all the parameters that the attachment feature requires to execute the command. This eight-word data block is commonly referred to as the Device Control Block (DCB).

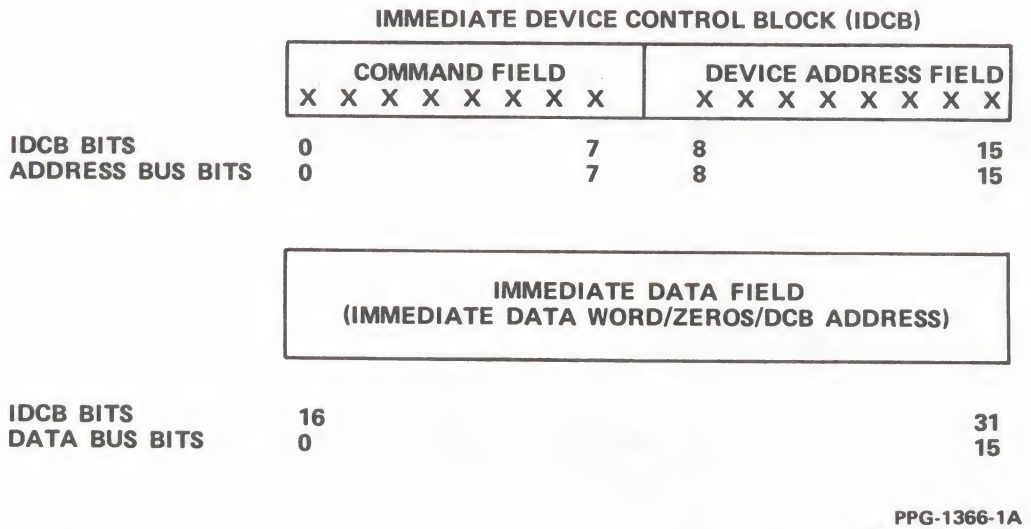


Figure 3-1. Immediate Device Control Block Word Formats

In both the CS mode and DPC, the attachment feature receives the IDCB that contains the command, checks the IDCB for errors and validity, and responds with the appropriate condition code. For commands executed under DPC, the attachment feature also performs the function requested.

For commands that do not require interrupts, the condition code provides current device status information. For commands that require an interrupt request, the first condition code provides information concerning the acceptance of the command by the attachment feature. When the processor services an interrupt, the attachment feature provides a second condition code and an interrupt word. The second condition code contains status information concerning the end-of-command execution. The interrupt word (see figure 3-2) provides the address of the device requesting the interrupt and zero-fills an interrupt information byte (IIB). If the condition code indicates an improper ending of the command execution, the IIB bits have special meanings, and the byte is referred to as an interrupt status byte (ISB).

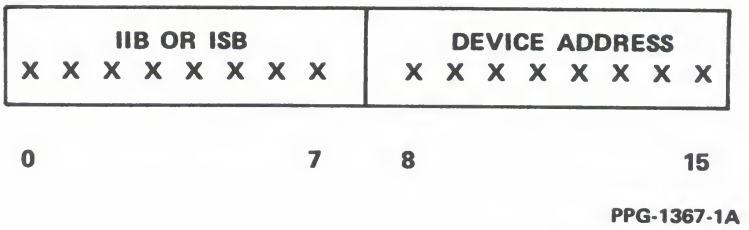


Figure 3-2. Interrupt Word Format

The attachment feature provides up to 5 bytes of status information for error recovery. The attachment feature transfers these bytes to the Series/1 processor via the Start Cycle-Steal Status command.

TAPE STORAGE SUBSYSTEM INTERFACES

The following paragraphs describe the signals and commands used with the two tape storage subsystem interfaces: the internal attachment-feature-to-tape-cartridge-drive QIC-02/QIC-24 intelligent interface, and the external attachment-feature-to-Series/1 I/O channel interface. The internal interface is described first.

ATTACHMENT-FEATURE-TO-TAPE-CARTRIDGE-DRIVE/FORMATTER QIC-02/QIC-24 INTERFACE

The QIC-02/QIC-24 intelligent interface controls the tape storage subsystem's formatter circuit card assembly. The interface provides a byte-parallel data bus architecture with asynchronous hand shaking. The drive records the data using the established QIC-24 format. Figure 3-3 shows the QIC-02/QIC-24 interface.

Attachment-Feature-to-Tape-Cartridge-Drive/Formatter Interface Signals

Table 3-1 summarizes the tape storage subsystem attachment feature/tape cartridge drive QIC-02/QIC-24 interface signals.

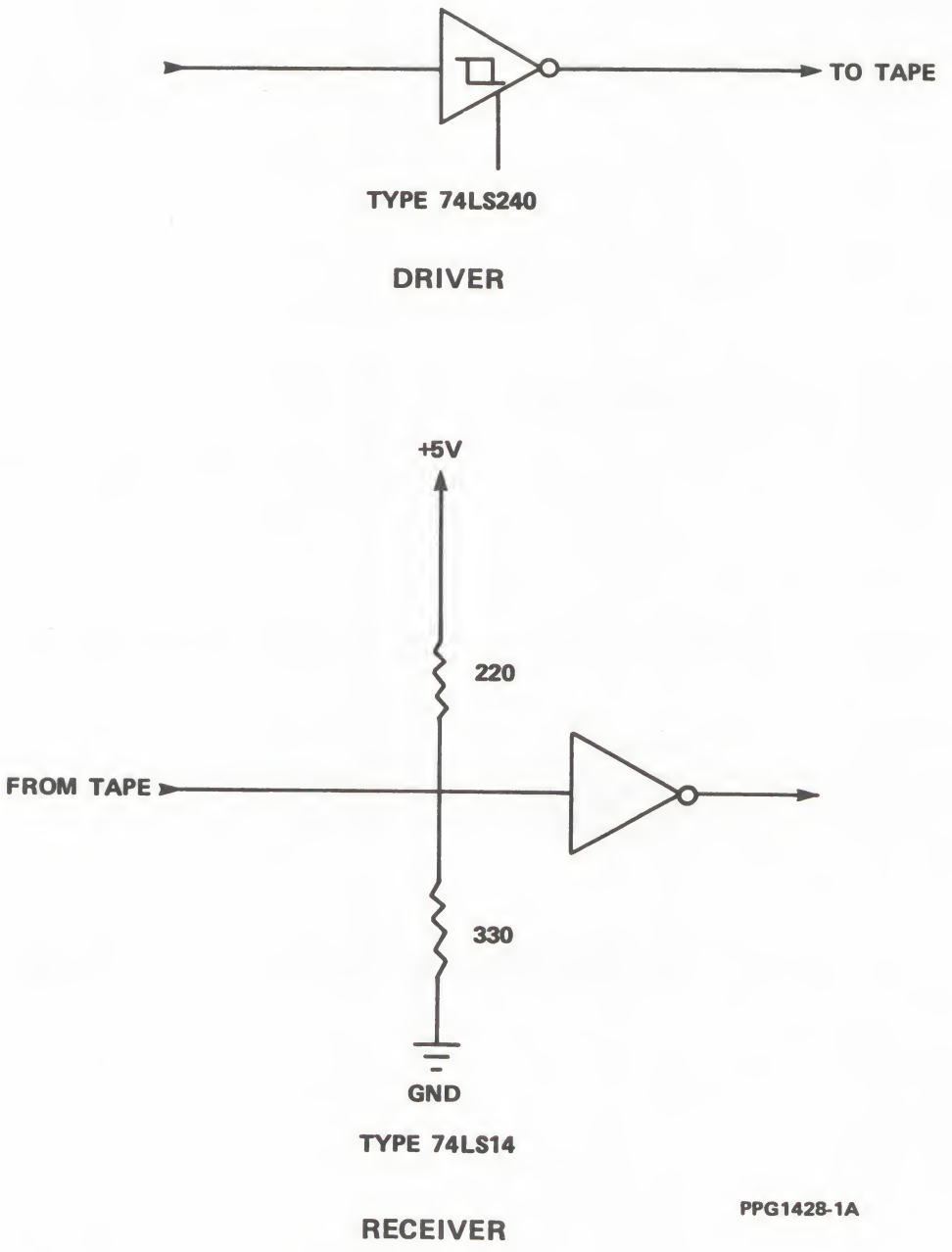


Figure 3-3. Attachment-Feature-to-Tape-Cartridge-Drive QIC-02/QIC-24 Interface

TABLE 3-1. ATTACHMENT FEATURE/FORMATTER QIC-02/QIC-24 INTERFACE SIGNALS

Signal	Definition
Host Bus Odd Parity	This signal is reserved for the use of the optional odd bus parity.
Host Bus (Bits 0 through 7)	This is the 8-bit bidirectional attachment feature data bus. Bus bit 7 is the most-significant bit (MSB), and bus bit 0 is the least-significant bit (LSB).
On-Line	The On-Line signal, which is an attachment-feature-generated signal, activates prior to transferring a Read or Write command and deactivates to terminate that Read or Write command.
Request	Request, which is an attachment-feature-generated signal, indicates that command data has been placed on the data bus in command mode or that status has been taken from the data-bus-in status input mode. The attachment feature only asserts the Request signal in response to a formatter-generated RDY- or EXC- command.
Reset	Reset, which is an attachment-feature-generated signal, enables tape initialization.
Transfer	Transfer is an attachment-feature-generated control signal. When active, the signal indicates placement of data on the data bus (in write mode) or that data has been taken from the data bus (in read mode).
Acknowledge	Acknowledge is a tape-cartridge-drive/formatter-generated signal. The drive activates the signal to indicate that data has been taken from the data bus (in write mode), or that data has been placed on the data bus (in read mode).
Ready	Ready is a tape-cartridge-drive/formatter-generated signal. The drive activates the signal to indicate one of the following: • When the tape cartridge drive/formatter is in the command transfer mode, data has been taken from the data bus. • When the tape cartridge drive/formatter is in the status input mode, data has been placed on the data bus.

TABLE 3-1. ATTACHMENT FEATURE/FORMATTER QIC-02/QIC-24 INTERFACE SIGNALS (Contd)

Signal	Definition
	• The tape cartridge drive/formatter completed a Restore, Re-tension, or Erase command. • When the tape cartridge drive/formatter is in write mode, the tape cartridge drive is ready to receive the next block or ready to receive a Write or Write File Mark (WFM) command from the attachment feature. • When the tape cartridge drive/formatter is in WFM mode, the tape cartridge drive completed a WFM command. • When the tape cartridge drive/formatter is in the read mode, the drive is ready to transmit the next block to the attachment feature or is ready to receive a Read or Read File Mark (RFM) command from the attachment feature. • The tape cartridge drive/formatter is ready to receive a new command from the attachment feature.
Exception	Exception is a tape-cartridge-drive/formatter-generated signal. When active, the signal indicates that an exception condition exists in the drive. When this signal is active, the attachment feature issues a status command and then performs a status input to determine the cause of the exception.
Direction	Direction is a tape-cartridge-drive/formatter-generated signal. When false, the signal causes the attachment feature's data bus drivers to assert their data bus levels and the tape cartridge drive's data bus drivers to assume high impedance status. When true, the signal causes the attachment feature's data bus drivers to assume high impedance status and the tape cartridge drive's data bus drivers to assert their data bus levels.

Table 3-2 summarizes the tape storage subsystem attachment feature/tape cartridge drive formatter command descriptions. The following paragraphs describe the commands. Note that all commands are single-byte commands. If the tape cartridge drive/formatter receives an undefined command code, the tape cartridge drive/formatter returns an illegal command status to the attachment feature.

TABLE 3-2. ATTACHMENT FEATURE/FORMATTER COMMAND SUMMARY

Command Byte	Command Description
0010 0001	Restore - positions tape to the beginning-of-tape (BOT) position
0010 0010	Erase the Entire Tape
0010 0100	Re-tension the Tape
0100 0000	Write Data
0110 0000	Write File Mark (WFM)
1000 0000	Read
1010 0000	Read File Mark (RFM)
1100 0000	Read Status

Power On/Reset

A power-on condition or a pulse on the reset line resets the tape cartridge drive and forces the drive to assert an Exception signal. When the power-on reset times out, or when the reset pulse terminates, the drive/formatter initializes operating parameters for subsequent commands. The formatter then waits for the attachment feature to issue a command.

Read Status Command (1100 0000)

The Read Status command provides the attachment feature with information about the tape cartridge drive. When the attachment feature issues a Read Status command, the formatter, in turn, transfers the standard status bytes to the attachment feature.

Restore Command (0010 0001)

The Restore command positions tape in the tape cartridge to the beginning-of-tape (BOT) position.

Re-tension Command (0010 0100)

The Re-tension command causes the drive mechanism to move the tape in the tape cartridge to the BOT position, then to the end-of-tape (EOT) position, and finally back to the BOT position. When using a new tape cartridge for the first time, issue the Re-tension command to assure proper tape tension during subsequent save/restore operations.

Erase Command (0010 0010)

The Erase command completely erases the tape in the cartridge drive. When executed, the Erase command moves the tape to the BOT position, activates the erase head, and then moves the tape to the EOT position. When the erase head reaches EOT, the drive deactivates the erase head and repositions the tape back to the BOT. The Erase command basically fulfills the requirements of a Re-tension command.

Write Command (0100 0000)

During a write sequence, the attachment feature asserts On-line and then issues the Write command. After the attachment feature issues the Write command, the tape cartridge drive/formatter can request and transfer data. The formatter activates the Ready signal when the formatter is ready for a data-block transfer. When the Ready signal is active, the attachment feature terminates the transfer of write data by issuing a Write File Mark (WFM) command. The attachment feature can alternatively terminate the transfer of write data by deactivating the On-line command. Deactivating the On-line command causes the writing of a file mark (if not preceded by a Write File Mark command) and the rewinding of the tape to the BOT.

A Write command following cartridge insertion or the issuing of a Reset command causes recording to begin at the BOT position. At all other times, recording begins at the current tape position.

NOTE

If the attachment feature starts transfer between blocks before asserting the Ready signal, Ready may not be asserted.

When the tape cartridge drive detects the early warning (EW) hole of the last track, the drive stops accepting data blocks from the attachment feature. When this occurs, the tape cartridge drive/formatter terminates the Write command and reports an end-of-media status with the Exception and Read Status commands.

NOTE

If the attachment feature issued a Write command, the tape cartridge drive/formatter allows the transfer of an additional 1024 bytes of data.

Read Command (1000 0000)

During a read sequence, the attachment feature asserts the On-line signal and then issues the Read command. After the attachment feature issues the Read command, the tape cartridge drive/formatter can transfer data. The attachment feature activates the Ready line when the tape cartridge drive/formatter is ready for a data-block transfer. The formatter terminates the Read command if the formatter detects a file mark. If the formatter detects a file mark, the attachment feature issues an Exception signal and a Read Status command sequence. When the attachment feature asserts the Ready signal, the feature may terminate the Read command by issuing a Read File Mark (RFM) command. If the attachment feature issues a Read command, the drive accepts the command and continues the read operation.

A Read command following cartridge insertion or the issuance of a Reset command causes the read operation to begin at the BOT position. At all other times, the read operation begins at the current tape position.

NOTE

If the attachment feature starts transfer between blocks before the drive asserts the Ready signal, the drive may not assert the Ready signal.

Write File Mark Command (0110 0000)

The Write File Mark (WFM) command causes the tape cartridge drive to write a file mark on the tape.

A WFM operation is specified by a Start DCB signal with the modifier of DCB word 0 equal to 60 (hexadecimal); only DCB word 0 is used. If bit 4 of DCB word 0 is set to a logical 0, the drive writes a 512-byte block on the tape preceding the file mark. This block consists of 508 bytes of zeros followed by a 4-byte CRC.

Read File Mark Command (1010 0000)

The Read File Mark (RFM) command causes the tape cartridge drive to advance the tape to the next file mark.

A RFM operation is specified by a start DCB with the modifier in DCB word 0 equal to A0 (hexadecimal); only DCB word 0 is used. If bit 4 of DCB word 0 is set to a logical 0, the drive tests the CRC generator/checker when reading a file mark. The results in the checker should be zero, indicating the drive detected no errors. If the drive detects an error(s), the attachment feature responds with an 02 condition code and sets bit 3 of status word 1.

Table 3-3 summarizes the tape storage subsystem attachment feature/tape cartridge drive-formatter status bytes. The following paragraphs describe the status bytes. Note these byte groups contain the device status, as returned by the Read Status command.

TABLE 3-3. ATTACHMENT-FEATURE-TO-TAPE-CARTRIDGE-DRIVE/FORMATTER STATUS BYTES

Byte 0	Byte 1	Acronym (EXS)	Description
BIT 01234567	01234567		
		POR	Power on/reset occurred
		RES	Reserved for end of recorded media
		RES	Reserved for bus parity error
		BOM	Beginning of media
		MBD	Marginal block detected
		NDD	No data detected
		ILL	Illegal command
		ST1	Status byte 1 bits
		FIL	File mark detected
		BNL	Bad block not located
		UDA	Unrecoverable data error
		EOM	End of media
		WRP	Write protected cartridge
		USL	Unselected drive
		CNI	Cartridge not in place
		STO	Status byte 0 bits

MSB	LSB	Acronym (EXS)	
Byte 2	Byte 3	DEC	Data error counter
Byte 4	Byte 5	URC	Underrun counter

NOTE

Bytes 0 and 1 contain exception status (EXC) to define the reason that the tape cartridge drive/formatter asserted an exception condition. A description of each status bit follows.

Status Byte 1

Bit significance for status byte 1 is as follows:

Bit 7: POR - The attachment feature sets the Power On/Reset (POR) bit after the feature asserts the Reset signal or when the tape cartridge drive/formatter is powered up. A Read Status sequence resets the bit.

Bit 6: RES - Reserved.

Bit 5: RES - Reserved.

Bit 4: BOM - The tape cartridge drive/formatter sets the beginning-of-media (BOM) bit whenever the cartridge is logically positioned at the BOT, track 0. The formatter resets the bit when the tape moves away from BOT, track 0. Note that when the drive/formatter sets any bit in byte 1 (except bit 4), the drive/formatter also sets Exception. A read status sequence does not reset bit 4.

Bit 3: MBD - The tape cartridge drive/formatter sets the marginal block detected (MBD) bit when the formatter determines that a data block is marginal. A read status sequence resets the bit.

Bit 2: NDD - The tape cartridge drive/formatter sets the no data detected (NDD) bit when an unrecoverable data error occurs due to a lack of recorded data. Absence of recorded data indicates that a data block was not detectable during an attachment-feature-generated timeout. A read status sequence resets this bit.

Bit 1: ILL - The tape cartridge drive/formatter sets the illegal (ILL) bit if the formatter encounters one of the following conditions. A Reset Status sequence resets the bit.

- The on-line signal is not asserted when the tape cartridge drive/formatter issues a Write, Write File Mark, Read, or Read File Mark command.
- The tape cartridge drive/formatter issues a command other than Write or Write File Mark during the execution of a write data sequence.
- The tape cartridge drive/formatter issues a command other than Read or Read File Mark during the execution of a read data sequence.

Bit 0: ST1 - The tape cartridge drive/formatter sets the status byte 1 (ST1) bit if any other bit in status byte 1 is set.

Status Byte 0

Bit significance for status byte 0 is as follows:

Bit	Status Byte 0
7	FIL - The tape cartridge drive/formatter sets the File mark detected (FIL) bit after detecting a File Mark signal during a read data or read file mark sequence. A read status sequence resets the bit.
6	BNL - The tape cartridge drive/formatter sets the block-in-error not located (BNL) bit when an unrecoverable read error occurs and the tape cartridge drive/formatter cannot confirm that the last block transmitted was the block in error. A read status sequence resets the bit.
5	UDA - The tape cartridge drive/formatter sets the unrecoverable data (UDA) bit when the tape cartridge drive/formatter experiences a hard error during read or write operations. A read status sequence resets the bit.
4	EOM - The tape cartridge drive/formatter sets the end-of-media (EOM) bit when the drive/formatter detects the logical early warning (EW) hole of the last track during a write operation. The EOM bit remains set as long as the drive is at the logical end-of-media status. A read status sequence cannot reset the EOM bit.
3	WRP - The tape cartridge drive/formatter sets the write-protected (WRP) bit if the system operator sets the tape cartridge write protect switch in the file protect (safe) position. The system operator must change the position of the write protect switch before the drive/formatter can reset the WRP status bit.
2	USL - The tape cartridge drive/formatter sets the drive unselected (USL) bit if the drive is not physically connected or is not receiving power. The system operator must correct the condition before the drive/formatter can reset this status bit.
1	CNI - The cartridge tape drive/formatter sets the cartridge not in place (CNI) bit if a tape cartridge is not fully inserted into the drive. The system operator must correct the condition before the drive/formatter can reset this status bit.
0	STO - The cartridge tape drive/formatter sets status byte 0 (STO) bit if any other bit in status byte 0 is set.

Status Bytes 2 and 3

Status bytes 2 and 3 contain the data error counter (DEC). The data error counter accumulates the number of blocks rewritten for write operations or the number of soft read errors detected during read operations. A read status sequence clears these bytes.

Status Bytes 4 and 5

Status bytes 4 and 5 contain the underrun counter (URC). The counter accumulates the number of times that streaming was interrupted because the attachment feature failed to maintain the minimum throughput rate. A read status sequence clears these bytes.

Attachment-Feature-to-Tape-Cartridge-Drive/Formatter Exception Status Summary

Table 3-4 provides a summary of the tape storage subsystem attachment feature/tape cartridge drive formatter exception status. These bytes, which are part of cycle-steal status word 2, define a tape error or illegal condition.

TABLE 3-4. EXCEPTION STATUS SUMMARY

Byte 0	Byte 1	Description
110X0000	00000000†	No cartridge - The selected drive did not contain a cartridge when the attachment feature issued Restore, WFM, Re-tension, Erase, Write, Read, or RFM commands; or the operator removed the cartridge while the drive was selected. This represents a fatal condition.
11110000	00000000	No drive - The selected drive was not present when the attachment feature issued Restore, Re-tension, Erase, Write, WFM, Read, or RFM commands. This represents a fatal condition.
10010000	X000X000	Write protected - The selected drive contained a write-protected (safe) cartridge when the attachment feature issued an Erase, Write, or WRM command. This represents a fatal condition.
10001000	00000000	End of media - During a write operation, the drive detected the logical early warning (EW) hole for the last track on the media. This represents a recoverable condition.

† X denotes either 0 or 1 condition.

TABLE 3-4. EXCEPTION STATUS SUMMARY (Contd)

Byte 0	Byte 1	Description
100X0100	10001000	Read or write abort - The attachment feature detected the maximum limit of same block rewrites during a Write or WFM command or an unrecoverable reposition error during a WFM, Write, Read, or RFM command. When a read or write abort occurs, the drive moves the tape to the BOT. This represents a fatal condition.
100X0100	00000000 †	Read error, bad block transfer - The maximum limit of same block retries has failed to recover the block without a CRC error. Also, the last transferred block contained data from the erroneous data block for off-line reconstruction. This represents a recoverable condition.
100X0110	00000000	Read error, filler block transfer - The maximum limit of same block retries has failed to recover the block without a CRC error. Also, the last transferred block contained filler data to keep the total block count correct. This represents a recoverable condition.
100X0110	10100000	Read error, no data - The read error, no data status, indicates the drive found no recorded data on the tape. This represents a recoverable condition.
100X1110	10100000	Read error, no data and EOM - The maximum limit of same block retries has failed to recover the next or subsequent blocks, and the drive encountered the logical end-of-tape (EOT) holes on the last track. This represents a recoverable condition.
100X0001	00000000	Read a Filemark - The drive read a filemark block during execution of a Read or Write command. This represents a recoverable condition.

† X denotes either 0 or 1 condition.

TABLE 3-4. EXCEPTION STATUS SUMMARY (Contd)

Byte 0	Byte 1	Description
XXXX0000	1100X000 †	Illegal Command - This status indicates that one of the following events has occurred: • The attachment feature tried to select more than one drive. • The attachment feature tried to change drive selection when a read or write operation moved the tape away from the BOT position. • The drive attempted to simultaneously execute a Restore, Re-tension, and/or Erase command. • The drive attempted to execute a Write, WFM, Read, or RFM command with the On-line signal not asserted. • The attachment feature attempted to issue a command other than Write or WFM during a write sequence. This represents a fatal condition. • The attachment feature attempted to issue a command other than Read or RFM during a read sequence. This represents a fatal condition. • The attachment feature attempted to assert an unknown or undefined command.
XXXX0000	1000X001	Power-on reset - The attachment feature detected a power-on reset or generated a reset. This represents a fatal condition.
100X0001	00010000	Marginal block detected - The tape cartridge drive/formatter detected a marginal data block. This represents a recoverable condition.
† X denotes either 0 or 1 condition.		

ATTACHMENT-FEATURE-TO-SERIES/1-PROCESSOR I/O CHANNEL INTERFACE

Figure 3-4 shows the tape storage subsystem attachment-feature-to-Series/1 I/O channel interface. This interface transfers data, address, and control signals between the attachment feature and the Series/1 processor. Refer to the following paragraphs for brief descriptions of the interface signals, which are TTL compatible.

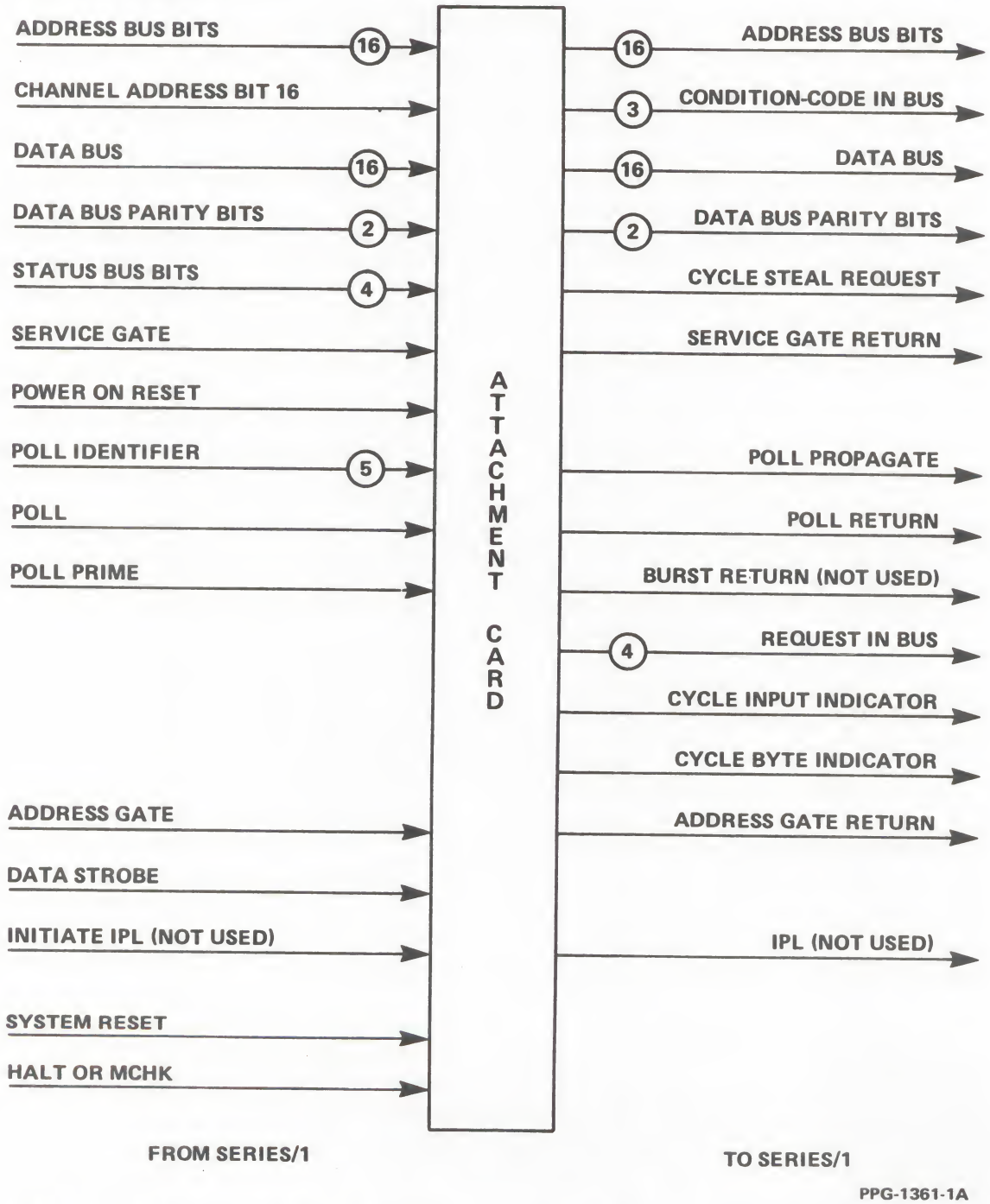


Figure 3-4. Attachment-Feature-to-Series/1 I/O Channel Interface

Address Bus (Bits 0 Through 15) Signal

This bidirectional 16-bit bus presents the address of the I/O device selected and a command code to the attachment feature during DPC command and cycle-steal sequences. The 16 bits are logically equal to the contents of the first 16-bit word of the IDCB. Address bus bit 0 (IDCB bit 0) is the channel select bit and can be ignored for device selection.

During cycle-steal sequences, the address bus presents Series/1 storage memory addresses to the Series/1 channel controls. The attachment feature drives the address bus. The address bits correspond to the address to or from which the data is to be transferred. Interrupt service sequences do not use address bus bits 0 through 15.

Channel Address (Bit 16) Signal

When active, this outbound tag signals a DPC sequence to the attachment feature. The receiver for this bit is always enabled.

Data Bus Signal

This 18-bit bidirectional data bus carries 16 bits of data and 2 parity bits (odd parity for each byte). On DPC command and interrupt servicing sequences, this bit transfers data and control information between the Series/1 processor and the attachment feature. During cycle-stealing sequences, the data bus carries information between the attachment feature and Series/1 main storage.

During DPC write sequences, data bus bits 0 through 15 reflect the contents of the second word (bits 16 through 31) of the IDCB. DPC write sequences are indicated on the address bus bits by setting bit 1 (IDCB bit 1) to logical 1.

During DPC read sequences, the attachment feature drives data bus bits 0 through 15 and stores the data bus bits as the contents of bits 16 through 31 (the second word) of the IDCB. The attachment feature indicates DPC read sequences on the address bus when bit 1 is set to a logical 0.

NOTE

For read and write operations in DPC sequences, parity must be maintained on both bytes of the data bus.

During interrupt servicing sequences, the data bus carries the interrupt identification (ID) word to the Series/1 processor. Data bus bits 0 through 15 correspond to bits 0 through 15 of the interrupt ID word; bits 0 through 7 contain an interrupt information byte (IIB), and bits 8 through 15 contain the address of the sending I/O device.

During cycle-steal sequences, both byte and word transfers may occur during the execution of a given cycle-steal operation. If the transfer is an output operation (from the Series/1 to the tape cartridge drive), the data bus bits have the following significance:

- On a word transfer, data bus bits 0 through 15 correspond to the word at the Series/1 storage memory address presented on the address bus lines by the attachment feature. The storage address must be even. For an output word transfer, the cycle input indicator equals a logical 0 and the cycle byte indicator equals a logical 0.

- On a byte transfer, data bus bits receive the byte from Series/1 storage memory according to the address presented by the attachment feature. If the given address is even, data bus bits 0 through 7 correspond to the byte at that address. If the given address is odd, data bus bits 8 through 15 correspond to the byte at that address. For an output byte transfer, the cycle input indicator equals a logical 0, and the cycle indicator equals a logical 1.

If the cycle-steal transfer is an input operation (from the tape cartridge drive to the Series/1), the data bus bits have the following significance:

- On a word transfer, the attachment feature drives the data bus. Bits 0 through 15 contain the word to be stored at the address the attachment feature presents. The storage address must be even. A logical 1 on the cycle-input indicator line, and a logical 0 on the cycle-byte indicator line indicates an input word transfer.

- On a byte transfer, the attachment feature drives the data bus and aligns the byte on the data bus according to the memory address where the byte is to be stored. If the memory address is even, data bus bits 0 through 7 carry the byte to be transferred. If the memory address is odd, data bus bytes 8 through 15 carry the byte to be transferred. A logical 1 on the cycle-input indicator line and a logical 1 on the cycle-byte indicator line indicates an input byte transfer.

NOTE

Parity must be maintained on both bytes of the data bus during cycle-steal sequences (for both input and output transfers). On output transfers, the attachment feature checks parity for both bytes of data whether a word or a byte is being transferred.

Address Gate Signal

During DPC sequences, this Series/1 outbound tag signals the attachment feature to respond to initial selection and to begin execution of the command coded on bits 0 through 7 of the address bus.

Address Gate Return Signal

During DPC sequences, this inbound tag from the attachment feature signals:

- The address gate has been received
- The condition-code in bus is active
- On a read sequence, the data bus is active

Service Gate Signal

The leading edge of this Series/1 outbound tag signals the attachment feature to begin a cycle-steal or interrupt-servicing sequence. The detection of the leading edge of this tag following a poll capture is called a service gate capture.

Service Gate Return Signal

This inbound tag from the attachment feature indicates the following:

- A service gate capture
- On a cycle-steal sequence, the activation of the address bus, activation of the data bus, condition-code in bus, and other tags required by a particular cycle-steal or interrupt-service sequence

Condition-Code In Bus Signal

The attachment feature activates this 3-bit, binary-coded inbound bus during DPC, interrupt, and cycle-steal sequences.

On DPC and interrupt sequences, the condition-code in bus carries the condition-code value to the level status register (LSR) in the Series/1 processor. The bus bits correspond to the LSR indicators as follows:

Condition-Code In Bit	LSR Indicator
0	Even
1	Carry
2	Overflow

On cycle-steal sequences, the active condition-code in bus carries the address key code to the Series/1 processor. On data transfers, the condition code bits are equal to the address key; that is, bits 5, 6, and 7, of the control word of the device control block (DCB) previously fetched from Series/1 memory by the attachment feature. During cycle-steal sequences for fetching a DCB and for reporting residual status, condition-code bits 0, 1, and 2 for the address key are set to a logical 0.

Cycle Input Indicator Signal

On cycle-steal sequences, this inbound tag from the attachment feature signals that the sequence involves either one of the following:

- An output from Series/1 memory (indicated by a logical 0)
- An input to Series/1 memory (indicated by a logical 1)

Cycle Byte Indicator Signal

On cycle-steal sequences, this inbound tag from the attachment feature signals that the sequence involves either one of the following:

- A word transfer (indicated by a logical 0)
- A byte transfer (indicated by a logical 1)

Status Bus Signal

During a cycle-steal sequence, this outbound 4-bit bus signals the attachment feature about any errors detected by the channel controls. Bus bit significance is as follows:

Status Bus Bit	Significance
0	Storage data check
1	Invalid storage address
2	Protect check
3	Interface data check

On any cycle-steal sequence, the attachment feature stores the status information. The attachment feature also returns status information to the Series/1 processor via ISB bits 4 through 7 of the interrupt ID word at interrupt-presentation time. When the status bus indicates an error, cycle-steal operations terminate and an exception interrupt occurs.

Data Strobe Signal

On DPC, interrupt, or cycle-steal service sequences, this outbound tag signals the attachment feature to complete the following actions:

- Accomplish control actions
- Register data on outbound transfers
- Perform appropriate data resets on inbound transfers

The Series/1 always activates data strobe on normal DPC write, cycle-steal, and interrupt service sequences. The Series/1 does not activate data strobe on DPC read sequences if the Series/1 channel controls detect a parity error.

Halt or MCHK Signal

This Series/1 outbound tag signals the attachment feature that one of the following has occurred:

- The Series/1 program has issued a Halt command
- A machine check class interrupt (except for a storage parity check) has occurred

After detecting this outbound tag, the attachment feature disables selection; blocks poll propagation; and clears any status states, interrupt requests, interface control logic, registers (except for the residual address), the prepare register level and I-bit, timer values, and those registers not addressable by the program. The receiver for this tag is always enabled.

System Reset Signal

This Series/1 outbound tag signals the attachment feature to disable selection block poll propagation and to clear any status states, interrupt requests, registers, interface control logic (except for the residual address), output sensor points, timer values, and those registers not addressable by Series/1 software. The receiver for this signal is always enabled.

Power-On Reset Signal

The Series/1 processor activates this outbound control line from the power supply on all power on/off sequences. While the line is active, the attachment feature is held in a system reset condition, and the residual address and timer values are reset. The attachment feature line count is set to one. The receiver for this line is always enabled.

Request In Bus Signal

The attachment feature issues this 16-bit inbound bus to request an interrupt on a level 0 to 3 corresponding to the value in the level field of the previous Prepare command. The attachment feature uses only the lower 4 bits of the bus.

Cycle-Steal Request Signal

The attachment feature issues this inbound bus during a cycle-steal sequence to indicate the attachment feature requires access to Series/1 storage memory.

Poll Identifier Signal

This 5-bit Series/1 outbound bus indicates the nature of the poll presently being propagated to the attachment feature. The poll identifier precedes the poll tag and remains active until the attachment feature issues a poll return signal. The attachment feature recognizes the following poll identifiers:

Poll Identifier Bits					Significance
0	1	2	3	4	
0	0	0	0	0	Poll for interrupt level 0
0	0	0	0	1	Poll for interrupt level 1
0	0	0	1	0	Poll for interrupt level 2
0	0	0	1	1	Poll for interrupt level 3
1	0	0	0	0	Quiesent value
1	X	X	0	1	Reserved
1	X	X	1	0	Reserved
1	X	X	1	1	Poll for cycle-steal

Poll and Poll Prime Signal

Series/1 I/O channel controls generate the serially propagated poll tag to resolve channel contention created by cycle-steal requests and multiple interrupt requests on the same level (refer to figure 3-5). The attachment feature receives the poll tag and redrives the poll tag to the next device on the I/O channel. The redriven poll is the poll propagate output signal. The poll prime tag is a poll signal that bypasses the previous device. The attachment feature recognizes a poll as the leading edge of the logical ANDing of the poll and poll prime tags.

Poll and poll prime are then ANDed with the results of a compare between the poll identifier bits and the value stored in the prepare register. If the compare is not equal, the poll tag is propagated to the next I/O device. If the compare is equal, the logical AND is successful and the poll is captured. If the poll is captured, the attachment feature responds with a poll return to the Series/1 processor channel controls.

Poll Propagate Signals

The attachment feature activates this outbound tag when the attachment feature receives a poll that the attachment feature does not capture.

Poll Return Signals

The attachment feature sends this inbound tag to Series/1 I/O channel controls to indicate a poll capture for interrupt servicing or nonburst cycle-steal servicing. The poll return tag is not used to signal a burst transfer.

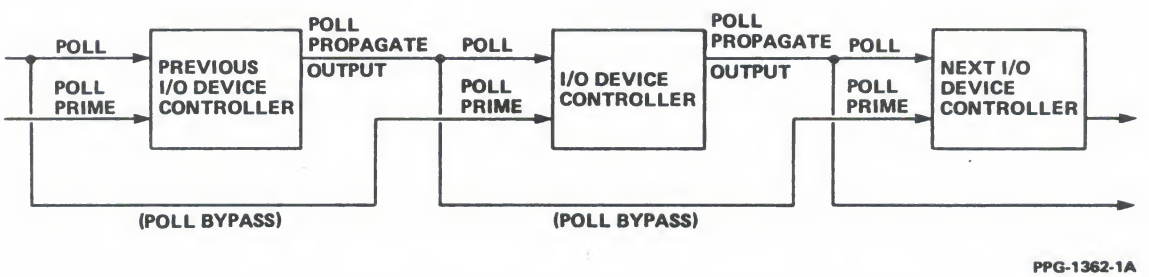


Figure 3-5. Poll and Poll Prime Arrangement

SERIES/1 PROCESSOR/ATTACHMENT FEATURE DPC COMMAND DESCRIPTIONS

The attachment feature receives commands, data, and channel error information from the Series/1 processor and responds with condition codes, interrupt information, and status words. Upon receiving a Start command from the processor, the attachment feature sends an equivalent command and control signals to the tape cartridge drive/formatter to perform the required I/O operation.

The attachment feature under direct program control (DPC) executes and/or issues acknowledgement of commands issued by the processor. Commands are received on address bus bits 0 through 7 corresponding to bits 0 through 7 of the IDCB. Address bus bits 8 through 15 contain the device address as given in IDCB bits 8 through 15. The data bus bits 0 through 15 correspond to the second IDCB word (bits 16 through 31) called the immediate data field. Table 3-5 shows the commands, their codes, use of the immediate data field as reflected on the data bus, and descriptions of the command function executed under DPC.

TABLE 3-5. DPC COMMAND SUMMARY

Command Name	Code (Address Bus Bits)		Data Bus Bits 0 Through 15	Description
	0 1 2 3	4 5 6 7		
Prepare	0 1 1 0	0 0 0 0	Bits 1-10 = zeros Bits 11-14 = interrupt level Bit 15 = enable interrupt (1) or disable interrupt (0)	Enter interrupt parameters into the prepare register. Must be received before executing an interrupt-causing command.
Device Reset	0 1 1 0	1 1 1 1	Data bus = zeros	Reset all pending interrupts and previously established control and status conditions. Does not reset device ID, device address, data address, residual address, and prepare registers.
Read Device ID	0 0 1 0	0 0 0 0	Data bus = zeros	Load the device ID word onto data bus bits 0 through 15 for processor storage.
Start	0 1 1 1	0 0 0 0	Data bus = DCB address	Initiate data transfer in cycle steal mode to execute one or more of the I/O operations described in DCB word 0 (see table 3-6).
Start Cycle Steal Status	0 1 1 1	1 1 1 1	Data bus = DCB address	Initiate data transfer in cycle steal mode to execute a cycle steal status I/O operation.
Start Diagnostic 1	0 1 1 1	1 1 0 1	Data bus = DCB address	Initiate microprocessor self test.
Start Diagnostic 2	0 1 1 1	1 1 1 0	Data bus = DCB address	Initiate an internal bus test.
Start Diagnostic 3	0 1 1 1	1 1 0 0	Data bus = DCB address	Initiate a RAM read, RAM write and execute, a read tape status, an ECC test, or a wrap test.

SERIES/1 PROCESSOR/ATTACHMENT FEATURE I/O OPERATIONS

Start and Start Cycle-Steal Status commands initiate I/O operations. The immediate data field of a Start or Start Cycle-Steal Status IDCB contains an address for a DCB. The DCB consists of eight contiguous 16-bit words, stored in processor memory, that define the parameters of an I/O operation.

	DCB (device control block)
Word 0	Control word
Word 1	Not used
Word 2	Not used
Word 3	Not used
Word 4	Reserved for diagnostics
Word 5	Chain address (next DCB address)
Word 6	Byte count
Word 7	Starting address of data storage address

DCB bits -- 0 7 8 15

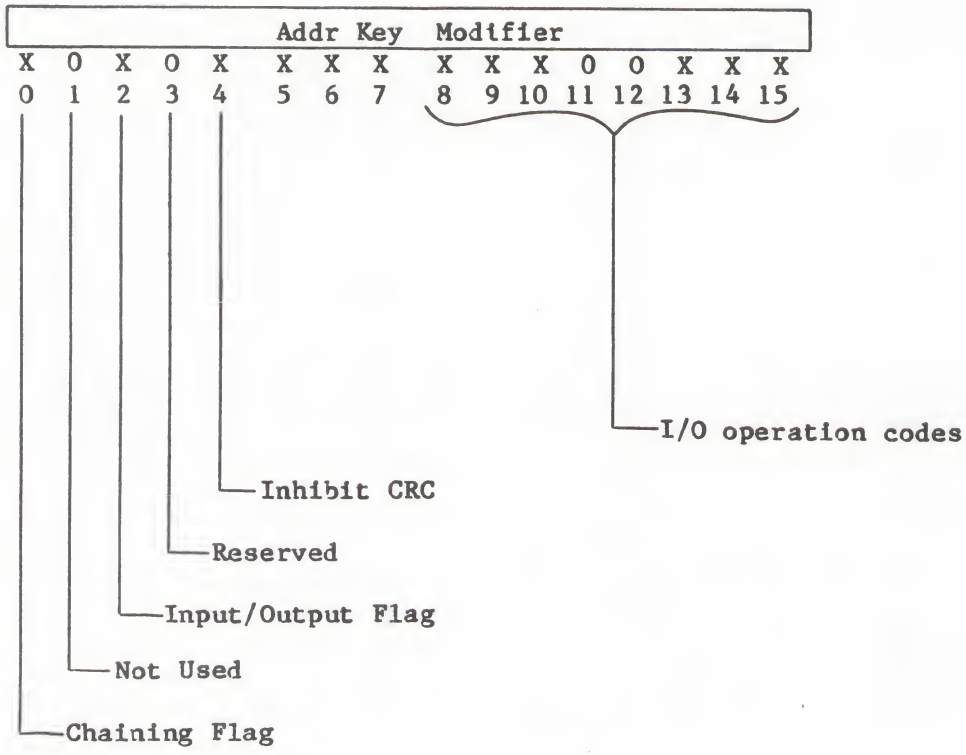
Data bus bits -- 0 7 8 15

DCB words are transferred in cycle-steal mode to the attachment feature via the data bus between the Series/1 channel and the attachment feature. You may chain DCBs together using bit 0 of word 0 and bits 0 through 15 of word 5. In this way, several I/O operations may be performed serially without interrupting the processor until the last DCB in the chain is executed.

DCB Word 0 - Control Word

The 16 bits of the control word contain the parameters for the cycle-stealing sequence and the binary code for the selected I/O operation.

DCB Control Word (DCB Word 0)



Bit 0 is a chaining flag. When set to a logical 1, the bit indicates that another DCB is to be executed following this DCB without an intervening processor interrupt if this DCB is executed successfully. The word 5 of this DCB contains the address for the next DCB. As the attachment feature executes each DCB in the sequence, the attachment feature uses the chain address stored in the current DCB to select the next DCB. The operation continues until the attachment feature executes the DCB that has the chaining bit in the control word set to a logical 0. If an error occurs, the attachment feature suspends the chaining operation, and the attachment feature sends an interrupt request to the processor. Command chaining reduces the processing time required to execute I/O operations.

DCB control word bit significance is as follows:

- Bit 0 is checked only if the command in the IDCB was a Start command.
- Bits 1 and 3 are not used and are set to logical 0's.
- Bit 2 is an input/output indicator. If bit 2 is a logical 0, the direction of data flow for the operation is from main processor storage. If bit 2 is a logical 1, the direction is to main processor storage.

- Bit 4, when set to a logical 1, inhibits CRC checking during read (restore) and write (save) operations.

- Bits 5, 6, and 7 contain a storage access authorization key used during a data transfer to main processor storage. If the key is not a valid key, a protect check occurs (bit 6 of the ISB is set to a logical 1).

- Bits 8 through 15 contain the various I/O operation codes (table 3-6). (Refer to applicable paragraphs presented earlier in this section for details on the various I/O operations listed in table 3-6.)

TABLE 3-6. I/O OPERATIONS

Modifier Bits 8 Through 15 (Hexadecimal)	Operation	Comments
21	Restore	
24	Re-tension	
A0	Read File Mark	
22	Erase Entire Tape	
60	Write File Mark	
80	Read Tape	Reads the number of bytes specified in DCB Word 6
40	Write Tape	Writes the number of bytes specified in DCB Word 6

NOTE

The attachment feature receives and properly responds to unused codes; however, unused codes cause no I/O operation to occur.

DPC-RELATED CONDITION CODES

The attachment feature sends a condition code to the processor at the completion of DPC execution of a command and at the end of a cycle-steal execution of an I/O operation requested by a command. For commands that do not cause interrupt requests, the condition code presented at the completion of the DPC mode represents the only status information available from the attachment feature. Table 3-7 summarizes and the following paragraphs describe the condition codes reported following DPC execution of commands.

TABLE 3-7. CONDITION CODES PRESENTED FOLLOWING DPC COMMAND EXECUTION

Condition Code In Bus Bits			Significance
2	1	0	
0	0	0	Device not attached
0	0	1	Busy
0	1	0	Busy after reset
0	1	1	Command reject
1	0	0	Not used
1	0	1	Interface data check
1	1	0	Not used
1	1	1	Satisfactory

Condition Code 0 - Device Not Attached

The I/O channel reports this condition code when the attachment feature is not attached to the Series/1.

Condition Code 1 - Busy

The attachment feature reports this condition code when the attachment feature is unable to execute a command because the feature is in the busy state. The attachment feature enters the busy state after accepting a command that requires an interrupt for termination. The attachment feature exits from the busy state when the Series/1 processor accepts the interrupt.

Condition Code 2 - Busy After Reset

The attachment feature reports this code when the attachment feature is unable to execute a command because of a reset and the attachment feature has not had sufficient time to return to the inactive state. No interrupt indicates termination of this condition.

Condition Code 3 - Command Reject

The attachment feature or Series/1 processor reports this code when the following occurs:

- A command is issued that is outside the attachment feature command set.
- The attachment feature is in an improper state to execute the command.
- The IDCB contains an incorrect parameter, such as an odd-byte DCB address or an incorrect function/modifier combination.

When the attachment feature reports a command reject, the feature does not fetch the DCB.

Condition Code 4

The tape storage subsystem does not use this condition code.

Condition Code 5 - Interface Data Check

The attachment feature or the Series/1 I/O channel reports this code when the I/O data bus detects a parity error during a data transfer.

Condition Code 6

The tape storage subsystem does not use this condition code.

Condition Code 7 - Satisfactory

The attachment feature reports this code when the attachment feature accepts a command.

INTERRUPT CONDITION CODES

Following execution of commands in cycle-steal mode and changes of status within the attachment feature that cause interrupts, the attachment feature reports a condition code to the processor at interrupt servicing time. Table 3-8 summarizes and the following paragraphs describe these codes.

TABLE 3-8. CONDITION CODES REPORTED AT INTERRUPT PRESENTATION TIME

Condition Code In Bus Bits			Significance
2	1	0	
0	0	0	Not used
0	0	1	Not used
0	1	0	Exception (error condition)
0	1	1	Device End (satisfactory)
1	0	0	Attention (ready signal goes low)
1	0	1	Not used
1	1	0	Not used
1	1	1	Not used

Condition Codes 0, 1, 5, 6, And 7

The tape storage subsystem does not use these condition codes

Condition Code 2 - Exception

The attachment feature reports this code when an error or exception condition is associated with the priority interrupt. The interrupt status byte (ISB) and the status information contained in the cycle-steal status block further describe this condition.

Condition Code 3 - Device End

The attachment feature reports this code when no error exception or attention conditions occur during the I/O operation and a normal termination of the operation occurs.

Condition Code 4 - Attention

The attachment feature reports this code when the feature becomes ready after being in a not ready state. Along with the interrupt condition code, the attachment feature also transfers an interrupt ID word, which provides additional information on the interrupting conditions.

INTERRUPT IDENTIFICATION

Status information presented at interrupt presentation time is available in an interrupt ID word. Bits 8 through 15 of the interrupt ID word contain the address of the interrupting device. Bits 0 through 7 indicate end-of-operation interrupt or attention interrupt and are the interrupt information byte (IIB). If the execution of Start commands fails to end satisfactorily, the IIB contains special information concerning the cause of the failure and is called an interrupt status byte (ISB). The ISB always accompanies an exception condition code (010). Table 3-9 summarizes ISB bit significance.

STATUS WORDS

The Start Cycle-Steal Status command transfers status words to the processor. The status words contain additional status information when exception condition code 010 is reported. The following paragraphs describe the various start cycle-steal status words used by the tape storage subsystem.

Cycle-Steal Status Word 0 - Residual Address

When the processor halts a cycle-steal transfer, the processor storage address where the last cycle-steal of data occurred remains in the address counter of the attachment feature. This is the residual address and is accessible as cycle-steal status word 0. If the last attempted transfer was a word, the residual address is the address of the odd byte of the word. Power-on reset causes the residual address to be reset to zero.

Cycle-Steal Status Word 1 - Tape Unit Status

This word provides the tape unit status at the time of the last Start-Command terminating interrupt. Table 3-10 summarizes bit significance for this word.

TABLE 3-9. INTERRUPT STATUS BYTE

Bit	Title	Significance
0	Device Status Available	When bit 0 is set to a logical 1, cycle-steal status word 1 provides additional information about the operation. Issue a Start Cycle-Steal Status command to obtain the information.
1	Delayed Command Reject	If the tape unit is off-line or the IDCB contains an incorrect parameter, the attachment feature is incapable of recording the condition on the condition code in bus because the I/O instruction is not executable. The operation is terminated and bit 1 is set to a logical 1. At interrupt servicing time, condition code 010 is reported. The residual address will not contain any relevant status information.
2	Not Used	Always 0.
3	DCB Specification Check	When bit 3 is set to a logical 1, the I/O operation has failed due to an invalid parameter in the DCB. Condition code 010 is reported at interrupt servicing time. Cycle-steal status word 0 contains a residual address pointing to the processor memory location of the invalid parameter. Issue a Start Cycle-Steal Status command to obtain the information.
4	Storage Data Check	When bit 4 is set to a logical 1, the operation ended because data accessed from processor storage during a cycle-steal output operation was out of parity. When this occurs, the parity of the data in the storage location is not corrected, a machine check does not occur, and condition code 010 is reported.
5	Invalid Storage Address	If a logical 1 is set in this bit, this indicates that the storage address specified in the DCB was beyond the capacity of processor storage. If this condition exists, the operation is halted immediately and condition code 010 is reported. This bit can be set on either an input or an output cycle-steal operation.
6	Protect Check	When bit 6 is set to a logical 1, an incorrect cycle-steal address key was used during an attempt to write data to processor storage. When this occurs, the operation is halted immediately and condition code 010 is reported at interrupt service time.
7	Interface Data Check	When bit 7 is set to a logical 1, a parity error occurred on the data bus interface to the attachment feature. When this occurs, the operation is immediately terminated and condition code 010 is reported.

TABLE 3-10. CYCLE-STEAL STATUS WORD 1

Bit	Title	Significance
0	Tape Not Operational	The tape unit is not ready.
1	ROM Test Failure	
2	RAM Test Failure	
3	CRC Error	Calculated CRC did not agree with the CRC written to tape.
4	Parity Error	
5	Not Ready Error	Tape did not go not ready within specified time limit.
6	Ready Error	Tape did not go ready within specified time limit.
7	Diagnostic 2 Error	Could not transfer data correctly on internal bus.
8-11	Not Used	
12	Status Bit 00	Storage data check.
13	Status Bit 01	Invalid storage address.
14	Status Bit 02	Protect check.
15	Status Bit 03	Interface data check.

Cycle-Steal Status Word 2

Status bytes 0 and 1 of cycle-steal status word 2 contain information related to any abnormal condition(s) detected by the tape cartridge drive/formatter. Bit significance for these 2 status bytes is as follows:

Bit	Status Byte 1
7	POR - The tape cartridge drive/formatter sets the power on/reset (POR) bit after the attachment feature asserts the Reset signal or when the tape cartridge drive/formatter is powered up. A read status sequence resets the bit.
6	RES - This is reserved.
5	RES - This is reserved.

Bit	Status Byte 1
4	BOM - The tape cartridge drive/formatter sets the beginning-of-media (BOM) bit whenever the drive/formatter logically positions the cartridge at the beginning-of-tape (BOT), track 0. The drive/formatter resets the bit when the tape moves away from BOT, track 0. Note that when the drive/formatter sets any bit in byte 1 (except bit 4), the drive/formatter also sets Exception. A read status sequence does not reset bit 4.
3	MBD - The tape cartridge drive/formatter sets the marginal block detected (MBD) bit when the tape cartridge drive/formatter determines that a data block is marginal. A read status sequence resets the bit.
2	NDD - The tape cartridge drive/formatter sets the no data detected (NDD) bit when an unrecoverable data error occurs due to a lack of recorded data. Absence of recorded data indicates the drive/formatter could not detect a data block during an attachment-feature-generated timeout. A read status sequence resets the bit.
1	ILL - The tape cartridge drive/formatter sets the illegal (ILL) bit if the drive/formatter encounters one of the following conditions. A reset status sequence resets the bit. • The drive/formatter does not assert the On-line signal when the drive/formatter issues a Write, Write File Mark, Read or Read File Mark command. • The drive/formatter issues a command other than Write or Write File Mark during the execution of a write data sequence. • The drive/formatter issues a command other than Read or Read File Mark during the execution of a read data sequence.
0	ST1 - The drive/formatter sets the status byte 1 (ST1) bit if any other bit in status byte 1 is set.

Bit	Status Byte 0
7	FIL - The tape cartridge drive/formatter sets the file-mark-detected (FIL) bit when the drive/formatter detects a File Mark during a read data or read file mark sequence. A read status sequence resets the bit.
6	BNL - The tape cartridge drive/formatter sets the block-in-error not located (BNL) bit when an unrecoverable read error occurs and the drive/formatter cannot confirm that the last block transmitted was the block in error. A read status sequence resets the bit.
5	UDA - The tape cartridge drive/formatter sets the unrecoverable data (UDA) bit when the drive/formatter experiences a hard error during read or write operations. A read status sequence resets the bit.

Bit	Status Byte 0
4	EOM - The tape cartridge drive/formatter sets the end-of-media (EOM) bit when the drive/formatter detects the logical early warning (EW) hole of the last track during a write operation. This bit remains set as long as the drive is at the logical end-of-media status. A read status sequence can not reset the EOM bit.
3	WRP - The tape cartridge drive/formatter sets the write protected (WRP) bit if the system operator sets the tape cartridge write protect switch in the file protect (safe) position. The drive/formatter does not reset this bit until the system operator changes the position of the write protect switch.
2	USL - The tape cartridge drive/formatter sets the drive unselected (USL) bit if the drive is not physically connected or is not receiving power. The drive/formatter does not reset this status bit until the system operator corrects the condition.
1	CNI - The tape cartridge drive/formatter sets the cartridge not in place (CNI) bit if a tape cartridge is not fully inserted into the drive. The drive/formatter does not reset this status bit until the system operator corrects the condition.
0	STO - The drive/formatter sets status byte 0 (STO) bit if any other bit in status byte 0 is set.

NOTE

Bytes 2 and 3 of cycle-steal status word 2 define a tape error or illegal condition. Table 3-4 provides a complete listing of the errors and illegal conditions.

Cycle-Steal Status Word 3

Bytes 0 and 1 of this status word contain the data error counter. The data error counter accumulates the number of blocks rewritten for write operations and the number of soft read errors detected during read operations. A read status sequence clears these bytes.

Cycle-Steal Status Word 4

Bytes 0 and 1 of this status word contain the underrun counter. The underrun counter accumulates the number of times the attachment feature interrupted streaming because the attachment feature failed to maintain the minimum throughput rate. A read status sequence clears these bytes.

RESETS

Several methods for resetting controls and registers are available. The following paragraphs briefly discuss these methods.

POWER-ON RESET

Power-on reset causes execution of internal register, data flow, and storage tests. Following successful tests, the attachment feature clears all internal buffer locations in the tape unit. Following a power-on reset, the attachment feature sets the residual address to zero.

SYSTEM RESET

When used, the system reset clears the prepare register, the last sector register, and any active cycle-steal request signal.

HALT I/O COMMAND

The Halt I/O command causes clearing of the last sector register and the active cycle-steal request signal.

DEVICE RESET COMMAND

The Device Reset command causes clearing of the last sector register.

BUILT-IN TEST FEATURES

The tape storage subsystem has the following built-in test features:

- A built-in diagnostic routine that tests the major logic elements (processor/ROM/RAM) in the attachment feature, and the data path between the major subsystem elements (attachment feature, formatter card, and tape cartridge drive).
- Built-in diagnostic commands which, when used with the basic diagnostic routine, allow fault detection and isolation.

For details on executing the tape storage subsystem built-in test features, refer to the 80810-10 Cartridge Tape Streamer Subsystem Hardware Maintenance Manual, publication 60467480.

ABBREVIATIONS AND ACRONYMS A

ACK	Acknowledge
BNL	Block-in-error not located
BOM	Beginning of media
BOT	Beginning of tape
CNI	Cartridge not in place
CPU	Central processor unit
CRC	Cyclical redundancy check
CS	Cycle-steal
CSS	Cycle-steal status (command)
DCB	Device control block
DEC	Data error counter
DIR	Direction
DMA	Direct memory access
DPC	Direct program control
ECC	Error condition code
EOM	End of media
EOT	End of tape
EW	Early warning (hole)
EXC	Exception
FIL	File (block detected)
GCR	Group code recording
HB	Host bus
HBP	Host bus parity
I/O	Input/output
IBM	International Business Machines Corporation

ID	Identification
IDCB	Immediate device control block
IIB	Interrupt information byte
ILL	Illegal (command)
IPL	Initial program load
IPS	Inches per second
ISB	Interrupt status byte
LP	Load point
LSB	Least-significant bit
LSI	Large-scale integration
LSR	Level status register
MB	Megabytes
MBD	Marginal block detected
MCHK	Machine check
MSB	Most-significant bit
NDD	No data detected
NRZI	Non-return to zero, change on one
NUS	Not used
ONL	On-line
POR	Power on reset
QIC-02	Quarter-inch cartridge (interface standard)
QIC-24	Quarter-inch cartridge (recording format standard)
R/W	Read/write
RAM	Random access memory
RDY	Ready
RES	Reserved
REQ	Request
RFM	Read file mark

ROM	Read only memory
RST	Reset
ST0	Status byte 0
ST1	Status byte 1
UDA	Unrecoverable data (error)
URC	Underrun counter
USL	Unselected (drive)
WFM	Write file mark
WRP	Write protected
XFR	Transfer

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360 Second Avenue Waltham, Ma. 02154

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